THE REPUBLIC OF UGANDA

WATER QUALITY THEMATIC REPORT

UGANDA DEMOGRAPHIC HEALTH SURVEY 2022

SEPTEMBER 2025

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Based on Uganda Demographic and Health Survey 2022

September 2025

This report presents findings based on further analysis of the Uganda Demographic and Health Survey (UDHS) 2022 undertaken by the Uganda Bureau of Statistics and Ministry of Water and Environment.

Additional information about the Survey may be obtained from Uganda Bureau of Statistics, Statistics House, Plot 9 Colville Street, P.O. Box 7186, Kampala; Telephone: (256-414) 706000; Email: ubos@ubos.org; Website: www.ubos.org.

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PREFACE

Water and Sanitation (WASH) is a crucial component of Sustainable Development Goal (SDG) 6, which aims to ensure access to clean water and sanitation for all. WASH is essential for achieving other SDGs related to health, education, and poverty reduction. Safe WASH contributes to livelihoods, school attendance and dignity and helps to create resilient communities living in healthy environments. Particularly Safe drinking water, sanitation and hygiene are crucial to human health and well-being.

The National Development Plan (NDP) IV recognizes Water, Sanitation, and Hygiene (WASH) as a cornerstone for fundamental to health, productivity, and a dignified life. The plan aims to improve access to safe water sources, reduce the distance to the nearest safe water source, and promote hygiene practices. The Uganda Bureau of Statistics (UBOS) through the Uganda National Household Survey (UNHS), Uganda Demographic and Health Survey (UDHS), and National Population and Housing Census (NPHC), has over time collected data on source of drinking water, distance to the water source and persons who collect the water. This focused-on responses provided by the respondent without subjecting the water to quality assessment tests.

For the first time, UBOS through the UDHS 2022 included a module on water quality testing and thus provides accurate and reliable statistics on the state of water quality in Uganda. This report, therefore, provides in-depth analysis of the survey findings on water quality for evidence-based policy formulation, planning and decision making.

The Bureau expresses gratitude to the Ministry of Water and Environment, UNICEF, and the Ministry of Health for the financial and technical support in producing this report.

The Uganda Bureau of Statistics, therefore, implores the public and policy makers to use the findings in this report to design programs and policies that ensure a healthier, more resilient, and prosperous Uganda. The UDHS 2022 Water quality thematic report and UDHS 2022 main report can be accessed at www.ubos.org.

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EXECUTIVE DIRECTOR

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ACRONYMS AND ABBREVIATIONS

APHA	American Public Health Association
AQC	Analytical Quality Control
CAPI	Computer-Assisted Personal Interviewing
CFU	Coliform Forming Units
DHS	Demographic and Health Survey
E. coli	Escherichia coli
EPA	Environmental Protection Agency
GDWQ	Guidelines for Drinking Water Quality
HH	Household
ICP-OES	Inductively Coupled Plasma-Optical Emission Spectroscopy
JMP	Joint Environment Monitoring Programme
MICS	Multi Indicator Cluster Surveys
Mg/L	Milligram per liter
MoH	Ministry of Health
MWE	Ministry of Water and Environment
NDP	National Development Plan
NWQRL	National Water Quality Reference Laboratory
SD	Standard Deviation
SDG	Sustainable Development Goals
UBOS	Uganda Bureau of Statistics
UDHS	Uganda Demographic and Health Survey
UNICEF	United Nations Children's Fund
WASH	Water, Sanitation and Hygiene
WHO	World Health Organization

CHAPTER 1: INTRODUCTION

1.1 Background

Access to safe and clean drinking water is a fundamental human right that is a crucial component of environment, public health, socio-economic development and essential for achieving Uganda's Vision 2040. The Sustainable Development Goals (SDGs) set ambitious targets for the measurement and reporting of drinking water, sanitation and hygiene (WASH). The WHO/UNICEF Joint Monitoring Programme (JMP) for Water Supply, Sanitation and Hygiene (JMP) has reported country, regional and global estimates of progress on drinking water, sanitation and hygiene (WASH) since 1990. For SDG 6.1 & 6.2 reporting, the JMP categorizes improved water and sanitation facilities into safely managed, basic and limited services. JMP estimates of population using safely managed drinking water, sanitation services and basic hygiene services are calculated from national Uganda Demographic Health Surveys (UDHS) and Uganda National Household Surveys (UNHS).

In 2015, Uganda adopted the United Nations Sustainable Development Goals (SDGs) to address global challenges. These goals include ending poverty and hunger, improving health and education, promoting gender equality, and ensuring access to clean water and energy. The country's commitment to the SDGs is reflected in its national development plans and collaborations with various stakeholders, including the UN and civil society.

In 2016, the Government of Uganda launched a framework to guide the coordination of the implementation of the agenda 2030 for Sustainable Development and its associated Sustainable Development Goals (SDGs) under the leadership of the Office of the Prime Minister. The framework brings together both state and non-state actors, including local governments, to accelerate and deliver on the SDGs and the Agenda 2030. Further, the framework spells out clear mandates for planning; coordination monitoring and reporting; resource mobilization; communication and advocacy; and data Technical Working Groups.

The Government of Uganda with contributions and support from many state and non-state stakeholders developed the second National SDG Roadmap for the period 2021 – 2025, to guide

the country's actions in implementing the globally-adopted, Sustainable Development Goals (SDGs). Uganda has made notable progress in increasing access to safe water, improved sanitation and hygiene practices across the regions of the country. The Uganda Demographic and Health Survey (UDHS) 2022, 82 percent of households in Uganda accessed improved drinking water sources, 31 percent households had improved sanitation, and 51 percent households had handwashing facilities.

1.2 About the Uganda Demographic Health Survey Water Quality Thematic Report

The Uganda Demographic Health Survey Thematic Water Quality Report presents calculation of safely managed Water based on nationally representative water quality testing. The report provides a comprehensive analysis of the current state of microbial and chemical water quality, highlighting key challenges, progress, and opportunities for improvement.

Table 1.1 Sustainable Development Goals Values based on JMP Estimates & UDHS 2022

Indicator definition	JMP Est. 2022	UDHS 2022
SDG 6.1.1: Percentage of Population Using Safely Managed Drinking Water Services	17	16
SDG 6.2.1a: Proportion of Population using Safely Managed Sanitation Services	20	n.a
SDG 6.2.1b: Proportion of Households with Hand washing Facilities Equipped with Soap and Water	23	43
Drinking Water		
Proportion of Population with Access to an Improved Water Source	84	82
Proportion of Population Using Basic Drinking Water Services	60	61
Proportion of Population Using Limited Drinking Water Services	25	20
Proportion of Population Using Unimproved Drinking Water Services	11	12
Proportion of Population Using surface water	5	7
Proportion of Water Samples at point of collection complying to drinking water Standards (E. coli)	39	42
Sanitation		
Percentage of Population using an Improved Sanitation Facility	41	34
Proportion of Population Using Basic Sanitation Services	23	30
Proportion of Population Using Limited Sanitation Services	18	24
Percentage of Households owning a sanitation facility	55	39
Proportion of Households with observed Open Defecation on the Premises	4	6
Hygiene		
Observed	54	51
Proportion of Households with Hand washing Present but lacking soap, water, or both	31	33
Proportion of Households with no Hand washing Facility on Premises	n.a	43

1.3 Organization of the report

This report comprises six (6) Chapters. Chapter 1 provides an introduction to the report, Chapter 2 presents the water quality methodology, including sample design and implementation. Chapter 3 presents the microbiological water quality findings. Chapter 4 discusses chemical water quality, risk categories, acceptable limits for drinking water and linkages of water quality with household practices, sanitation and hygiene. Chapter 5 presents results on safely managed water services. Chapter 6 outlines the limitations of the report and recommendations.

CHAPTER 2: WATER QUALITY METHODOLOGY

2.1 Survey Design

The objective of the water quality testing module within the Uganda Demographic and Health Survey was to obtain a nationally representative status of household's drinking water quality at the source of water for drinking. The survey design utilized random systematic sampling in which 3,414 households out of 20,032 households in the main household survey were selected for water quality testing and 683 households were selected for blank testing.

Households selected for water quality testing were asked to provide a glass of water typically used for household drinking purposes. Permission was sought from all the households visited to test the household drinking water for E. coli and where the consent was given, then household drinking water in the glass was tested for E. coli as per the testing protocol. The water quality survey questionnaire was also duly filled and appropriately completed. In addition, the household was requested to indicate the primary source of drinking water for E. coli testing and chemical testing. Furthermore, a water sample from the drinking water source was collected in a clean one-liter plastic bottle, properly labeled. Furthermore, GPS coordinates of the source location were captured at the time of sampling and a Sample Submission Form (SSF) was completed for submission with the source water sample to the National Water Quality Reference Laboratory (NWQRL) in Entebbe. This approach allowed for the assessment of both household and source of drinking water.

The list of all households selected for water quality testing were generated from the Computer-Assisted Personal Interviewing (CAPI) system to ensure randomness. The water quality questionnaire, results for household E. coli, source and blank tests were filled manually and were captured into the CAPI system by the supervisor. Table 2.1 and 2.2 shows the response rate for implementation of the water quality testing questionnaire.

Table 2.1 Response Rate of the household water quality testing

Item description	Selected	Completed	Response Rate (%)
Household main survey questionnaire	20,032	19,758	98.6
Household E. coli Testing	3,414	3,294	96.5
Source E. coli Testing	3,414	3,078	90.2
Blank E. coli Testing	683	674	98.7
Source Chemical Testing	3,414	3,078	90.2

Table 2.2 Water Quality Testing Response Rates

Parameters	Samples Received	Samples Tested	Percentage Samples Tested
Household E. coli Testing	3,294	3114	95.5
Source E. coli Testing	3,078	3043	98.9
Blank E. coli Testing	674	674	100
Lead	3078	848	27.5
Arsenic	3078	872	28.3
Nitrate	3078	2403	78.1
Fluoride	3078	2570	83.5

2.2 Training and Field Operations

Twenty-One (21) Teams each comprising of four (4) Interviewers, one (1) Supervisor, and One (1) Health Technician were trained in administration of the water quality questionnaire, sampling and testing. The Health Technician in each Team was responsible for administering the water quality questionnaire, E.coli testing for household, source and blank samples for chemical testing. The interviewer in each team administered the main UDHS questionnaire and the Supervisor was responsible for the CAPI.

Ten (10) days training of Health Technicians in anthropometry and water quality testing modules of the main UDHS was conducted by Water Quality Experts from Joint Monitoring Program (JMP/WHO), Ministry of Health (MoH) and the Ministry of Water and Environment (MWE). Training sessions were structured to ensure that Health Technicians acquired practical knowledge and hands on skills to collect high-quality and reliable data.

Training on anthropometry dealt with knowledge and skills of field teams on techniques and protocols for weight and height measurements and water quality training concentrated on knowledge and skills on proper water quality sampling and E. coli testing. PowerPoint presentations on theoretical aspects of water quality testing and hands-on practical exercises using real water samples were undertaken during the training sessions in close supervision of Water Quality Experts. The competence of the Health Technicians was evaluated and areas of weakness identified, and additional practice given to perfect the participants re-evaluated to ensure reliable test results are generated by each field team.

Field practice in the real survey situation was undertaken in the nearby community of Lunyo Ward in Entebbe Municipality. The field practice covered all aspects of the survey, including anthropometry, to ensure that all Team Members were thoroughly prepared and familiar with the survey protocols and procedures. The joint field practice also allowed the Health Technicians to apply the knowledge and skills under close supervision, alongside the other survey Team Members. Any questions and gaps identified during the field practice test runs were addressed and further demonstrations undertaken where necessary. All questionnaires, Sample Submission Forms and field checklists were fully completed and the results generated were discussed and reported in accordance with the water quality testing manual. The care of equipment used for sampling and testing was also emphasized for consistent application of the protocols.

2.3 Sample Collection and E coli testing

Water samples were collected from households and water sources in accordance with the MICS Manual for Water Quality Testing (JMP/UNICEF/WHO, 2016). Source of drinking water samples were collected using a sampling cup provided with the water testing equipment, filtered and incubated immediately for E. coli test. In cases where immediate filtration of samples was not possible all samples were collected in a sterile 100 ml Whirl-Paks, appropriately labelled and processed within 6 hours from the time of sampling.

In the collection of water samples for E. coli aseptic techniques and personal hygiene in handling samples and equipment was emphasized to avoid cross contamination. In addition, blank samples were tested for selected households for E. coli to ensure quality assurance measures are effective.

Drinking water sources samples for physical and chemical tests were collected in clean, one litre plastic bottles without preservation, appropriately labelled and transported in cool boxes to the National Water Quality Reference Laboratory in Entebbe. During sampling, disinfection of water sources was not undertaken to deal with potential contamination introduced by unsanitary handling of taps or tube well spouts by users to provide a good measure of the water quality as it is actually used by the households as per MICS water quality testing Manual.

2.4 Water Quality Questionnaire

The questionnaire captured detailed information on the water quality testing process, including the sample collection and handling, as well as E. coli results. In addition, information on source types for drinking water, household water treatment, and household drinking water storage practices.

2.5 Quality Assurance

Makerere University School of Public Health (MakSPH) provided supervision and quality assurance of all field data collection processes of the main Uganda Demographic Household Survey.

2.5.1 Blank Testing

One blank sample for E. coli was tested for every five households selected for water quality testing. Blank testing was conducted in order to detect onsite/field contamination in sample handling. Additionally, the field blanks were used to verify the purity of sample fixatives and identify potential lab contamination issues. The Team Supervisor was responsible for blank water samples to be tested for E. coli alongside the household and source water samples.

Blank sample test results showed six (6) out of 674 blank samples tested positive for E. coli representing 0.9% positivity. The results were well within the ≤5% acceptance criteria provided by the World Health Organization.

2.5.2 Analytical Quality Control

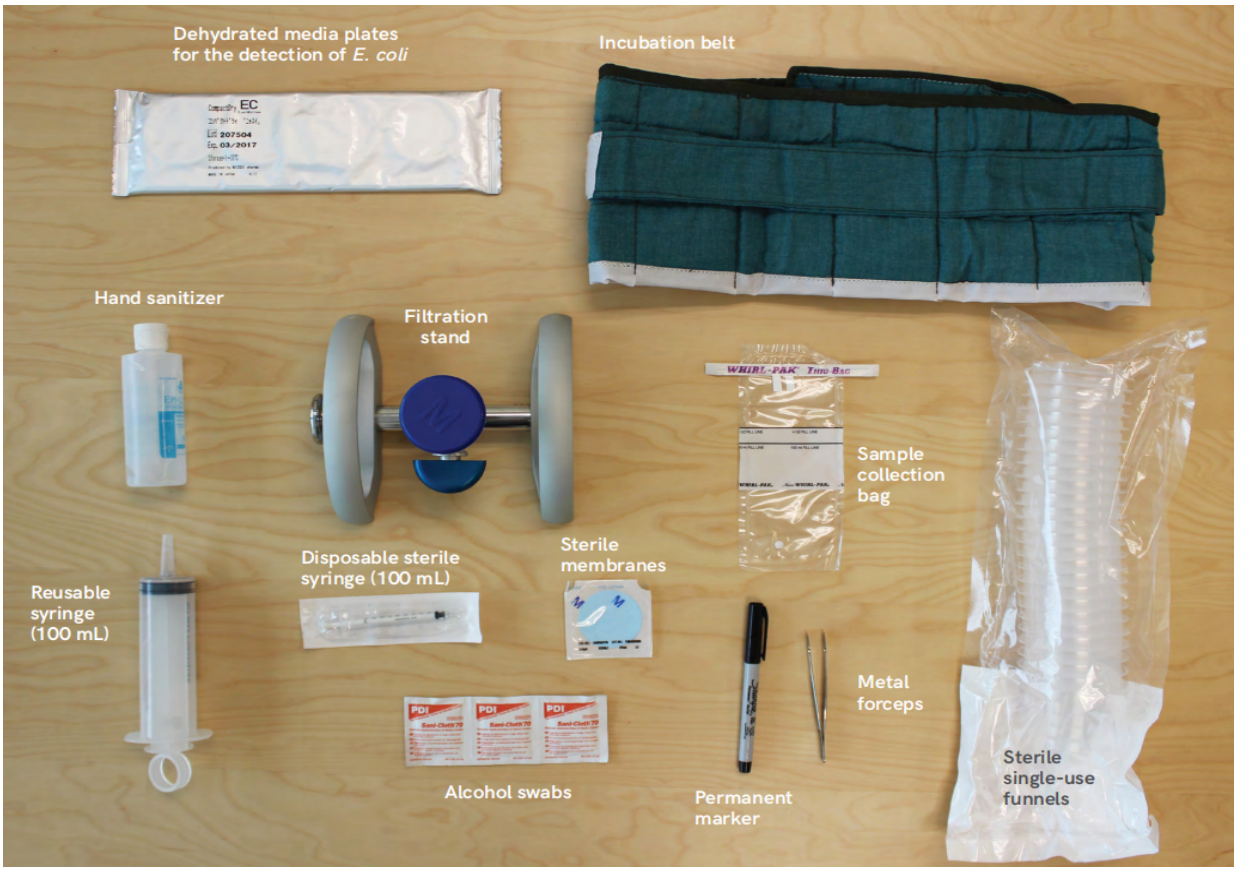
Analytical Quality Control samples, Certified Reference Materials and Proficiency Testing Samples were used to ensure the reliability of the test results for the chemical tests. The National Water Quality Reference Laboratory of the Ministry of Water and Environment participate in the Proficiency Testing Scheme with NLA and SADACMET. In addition, intermediate checks, re-testing of retained items, testing of blank and blind samples are undertaken to ensure the reliability of test results. Laboratory test results were accepted only when AQC samples, CRMs were within ±2SD of the target value. Results from duplicate samples were accepted when the difference between the original sample and duplicate sample was ±10%.

2.6 Microbial water quality testing

The same protocol was followed for all blank samples. Figure 2.1 shows the Key components of JMP microbiological water quality testing for E. coli and Annex 2.6.1 presents a pictorial step by step process for testing for E. coli. The Escherichia coli bacterium was selected as an indicator organism for measurement of source and household drinking water microbiological contamination. E. coli is a widely used and recommended indicator by the World Health Organization for assessment of recent fecal contamination of drinking water supply. The presence of E. coli in drinking water is often associated with recent contamination of drinking water with fecal material of human or animal origin and signifies presence of pathogenic organisms with potential health risks to consumers. Household and source drinking water samples were tested for E. coli using membrane filtration method/compact dry method. 100ml of the water sample was filtered through a sterile 0.47-micron membrane filter. After filtration, the filter membrane was placed using sterile forceps onto a Compact Dry TM EC plate disc containing rehydrated selective medium. The compact dry EC plate disc was incubated using incubation belts for 24 hours.

After incubation, when blue/green colonies were observed they were counted and recorded directly in the questionnaire as the number of Colony Forming Units per 100ml (CFU/100ml) regardless of their sizes. When white, brown, yellow, pale blue or any other color including no growth was observed then E. coli was absent and the result was recorded on the questionnaire as zero CFU/100 ml.

Figure 2.1 Key components of JMP kit required E. coli testing



2.7 Laboratory Analysis

Laboratory analysis for Arsenic and Lead in source drinking water samples was conducted in the National Water Quality Reference Laboratory of the Ministry of Water and Environment using Inductively Coupled Plasma Emission Spectrometer (ICP-OES) while for Fluoride and Nitrates Gallery Plus Analyzer was used (*Figure 2.2*).

The Standard Test Methods used in analysis are documented in the Procedures Manual[1]. Annex 3 and 4 present Test Method performance characteristic for Arsenic & Lead by ICP-OES and Fluoride & nitrates by Gallery Plus analyzer.

Figure 2.2 Inductively Coupled Plasma Emission Spectrometer and Gallery Plus Analyzer

2.8 Data Analysis

The World Health Organization drinking water quality guidelines (WHO 2014, 4th Edition) and East African Community potable water specifications (DEAS 12:2018) frameworks were used to describe and define water quality health targets (Table 2.3) as well as categorize water risks (Table 2.4) during the data analysis.

[1] Test Methods and Standard Operating Procedures as per the requirements of ISO/IEC 17025:2017 for water testing and calibration laboratories (*Annex 2.6.2 and 2.6.3*)

Water quality targets identify priority drinking-water constituents that pose long-term health risks and include thresholds for *E. coli* contamination in both household and source water.

Water quality data editing and cleaning was done using CSPro software while Ms. Excel, Stata 14 and SPSS v29 provided robust statistical analysis software tools for presentation population parameters and calculating standard errors (Table 2.5). The results of the analysis are presented in the following sections of this report.

Table 2.3: Water Quality targets for drinking water

Potable Water Category	**Treated**	**Natural**
Parameter /Units		
E. coli (CFU/100ml)	<1	<1
Arsenic as As (mg/L)	0.01	0.01
Lead as Pb (mg/L)	0.01	0.01
Nitrate as NO_3 (mg/L)	50	50
Fluoride as F (mg/L)	1.5	1.5

Table 2.4: Water quality risk categories

CFU/100ml	**WHO Risk Category**	**Actionable Priority**
<1	Low Risk	No Action Required
1-10	Intermediate Risk	Low Action Priority
11-100	High Risk	Higher Action Priority
>100	Very High Risk	Urgent Action Required

Table 2.5: Results of household and household water quality testing interviews
Number of households, households selected for water quality testing results, by area of residence and region, DHS Uganda, 2022

	National	Kampala	Buganda	Busoga	Bukedi	Elgon	Teso	Karamoja	Lango	Acholi	West Nile	Bunyoro	Tooro	Ankole	Kigezi
Households															
Sampled	20,481	1,350	3,294	1,800	1,200	1,227	1,260	1,050	1,320	1,170	1,440	1,350	1,470	1,410	1,140
Occupied	19,898	1,328	3,182	1,765	1,164	1,200	1,226	1,017	1,298	1,151	1,387	1,321	1,405	1,360	1,094
Interviewed	19,758	1,316	3,143	1,760	1,154	1,187	1,226	1,016	1,293	1,147	1,373	1,317	1,396	1,350	1,080
Household completion rate	97	98	95	98	96	97	97	97	98	98	95	98	95	96	95
Household response rate	99	99	99	100	99	99	100	100	100	100	99	100	99	99	99
Water quality testing [A]															
Sampled	3,414	225	549	300	200	205	210	175	220	195	240	225	245	235	190
Occupied	3,342	223	529	297	195	203	204	170	217	195	233	222	234	233	187
Household water quality test: Completed	3,265	215	507	291	194	200	201	167	216	193	227	216	226	231	181
Household water quality test: Completion rate	95.6	95.6	92.3	97	97	97.6	95.7	95.4	98.2	99	94.6	96	92.2	98.3	95.3
Household water quality test: Response rate	97.7	96.4	95.8	98	99.5	98.5	98.5	98.2	99.5	99	97.4	97.3	96.6	99.1	96.8
Source water quality test: Completed	3,060	202	461	280	176	182	194	167	209	180	221	196	192	228	172
Source water quality test: Completion rate	89.6	89.8	84.0	93.3	88	88.8	92.4	95.4	95	92.3	92.1	87.1	78.4	97.0	90.5
Source water quality test: Response rate	91.6	90.6	87.1	94.3	90.3	89.7	95.1	98.2	96.3	92.3	94.8	88.3	82.1	97.9	92

[A] The Water Quality Testing Questionnaire was administered to 5 randomly selected households in each cluster

CHAPTER 3: MICROBIOLOGICAL WATER QUALITY

3.1 Introduction

Microbiological water quality refers to the presence and concentration of microorganisms such as protozoa, bacteria, and viruses in water, especially those that may pose health risks to humans. Escherichia coli is one of the many groups of faecal coliforms that is used as an indicator of possible presence of disease-causing germs (Bekele et al 2023) and establishes if water is polluted with faecal matter. (Saturday et al. 2022).

The presence of *E. coli* in drinking water does not necessarily mean that a person will become ill, but it signals a potential risk for waterborne diseases. (Stupar Z et al 2022, Phillips et al. 2022, Morgan CE et al. 2021).

Potable water standards (specifications) and the WHO guidelines provide the requirements for drinking water as a basis of measurement of compliance. In this report, the Potable water specifications are used to assess the microbiological water quality of source and household drinking water.

3.1 Microbiological water quality of source and household drinking water

Figure 3.1 shows that 42.1% of drinking water sources (point of collection) and 11.1% of household drinking water (point of use) were free from E. coli contamination. By place of residence, 43.1% of water sources and 20% of household drinking water in urban areas were safe, compared to 42% of water sources and just 7.2% of household drinking water in rural areas. Overall, E. coli contamination was higher in rural areas than in urban areas, by about 2 percentage points for water sources and 13 percentage points for household drinking water

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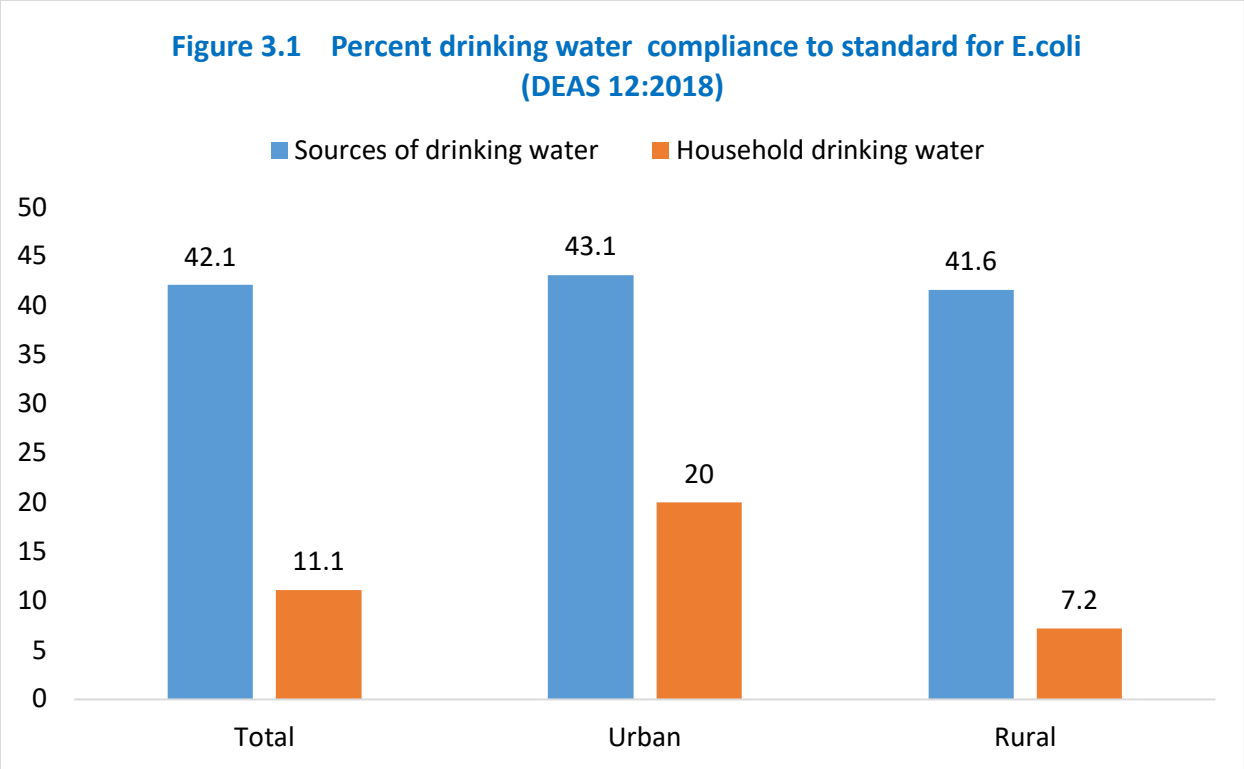


3.2 Microbiological water quality by Sub-Regions

Overall, the results highlight significant disparities in *E. coli* contamination between water sources and household drinking water across Uganda's sub-regions. Four of the 14 sub-regions namely Bukedi (86%), Kampala (76%), Karamoja (73%) and Busoga (64%) recorded proportions of drinking water sources free from *E. coli* contamination well above the national average of 42%. Kampala also had the highest share (22%) of households with *E. coli*-free drinking water (Figure 3.2, Map 3.1 and Map 3.2).

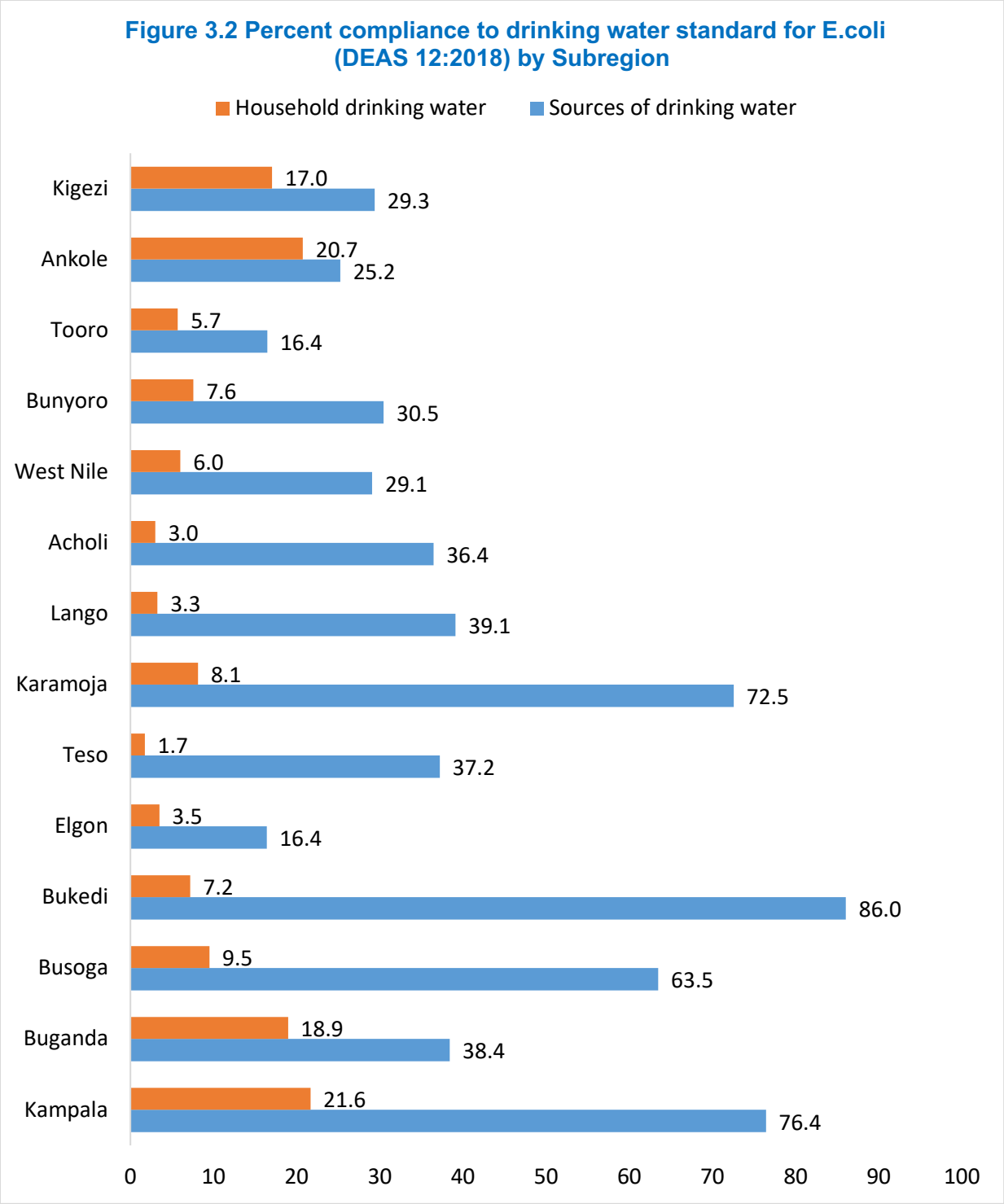
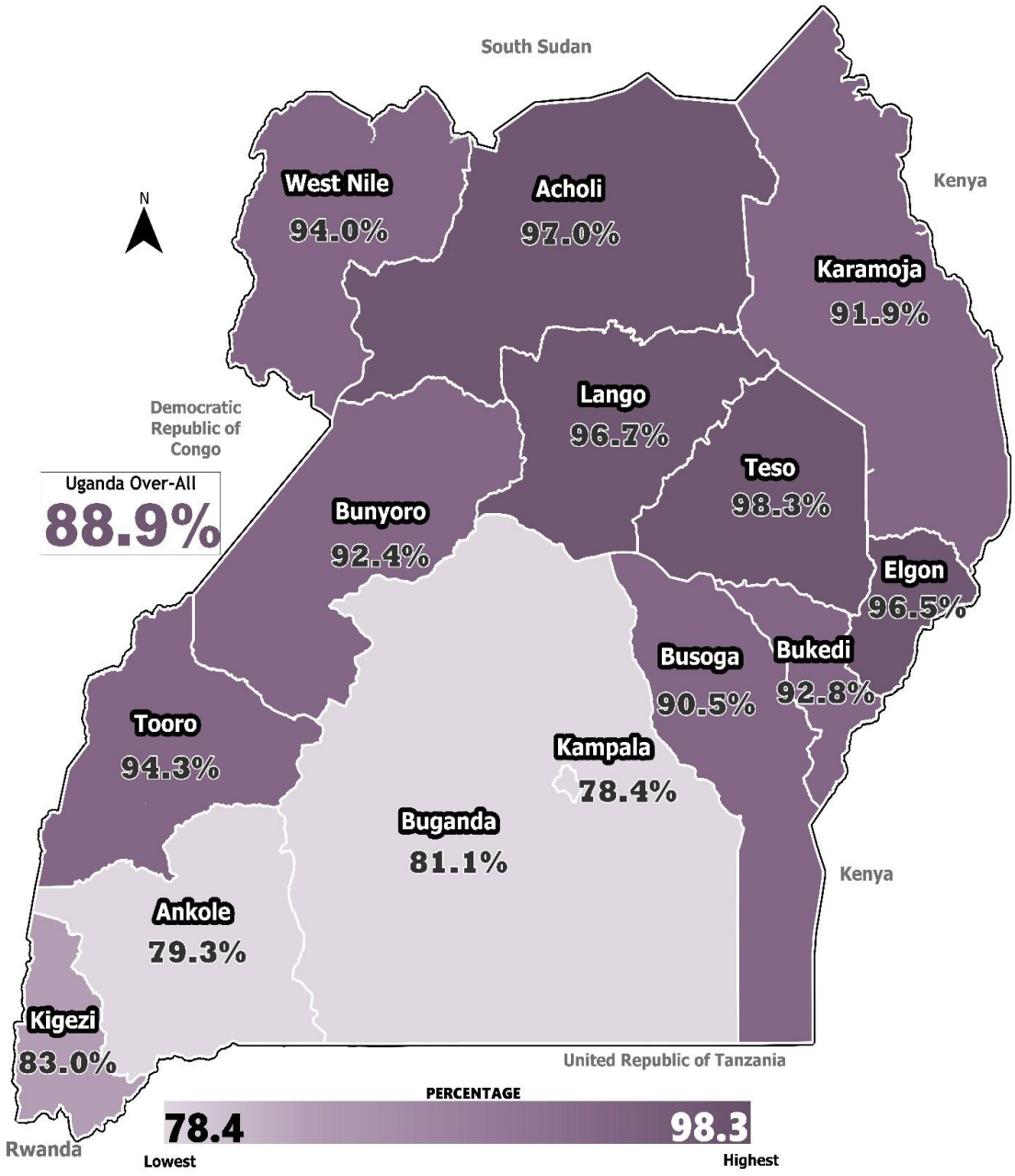


Figure 3.2 Percent compliance to drinking water standard for E.coli (DEAS 12:2018) by Subregion
Household drinking water
Sources of drinking water
Kigezi
17.0
29.3
Ankole
20.7
25.2
Tooro
5.7
16.4
Bunyoro
7.6
30.5
West Nile
6.0
29.1
Acholi
3.0
36.4
Lango
3.3
39.1
Karamoja
8.1
72.5
Teso
1.7
37.2
Elgon
3.5
16.4
Bukedi
7.2
86.0
Busoga
9.5
63.5
Buganda
18.9
38.4
Kampala
21.6
76.4
0
10
20
30
40
50
60
70
80
90
100

Map 3.1: Percentage of households whose drinking water is contaminated with E. coli



Map 3.2: Percentage of Improved drinking water sources with E. coli contamination

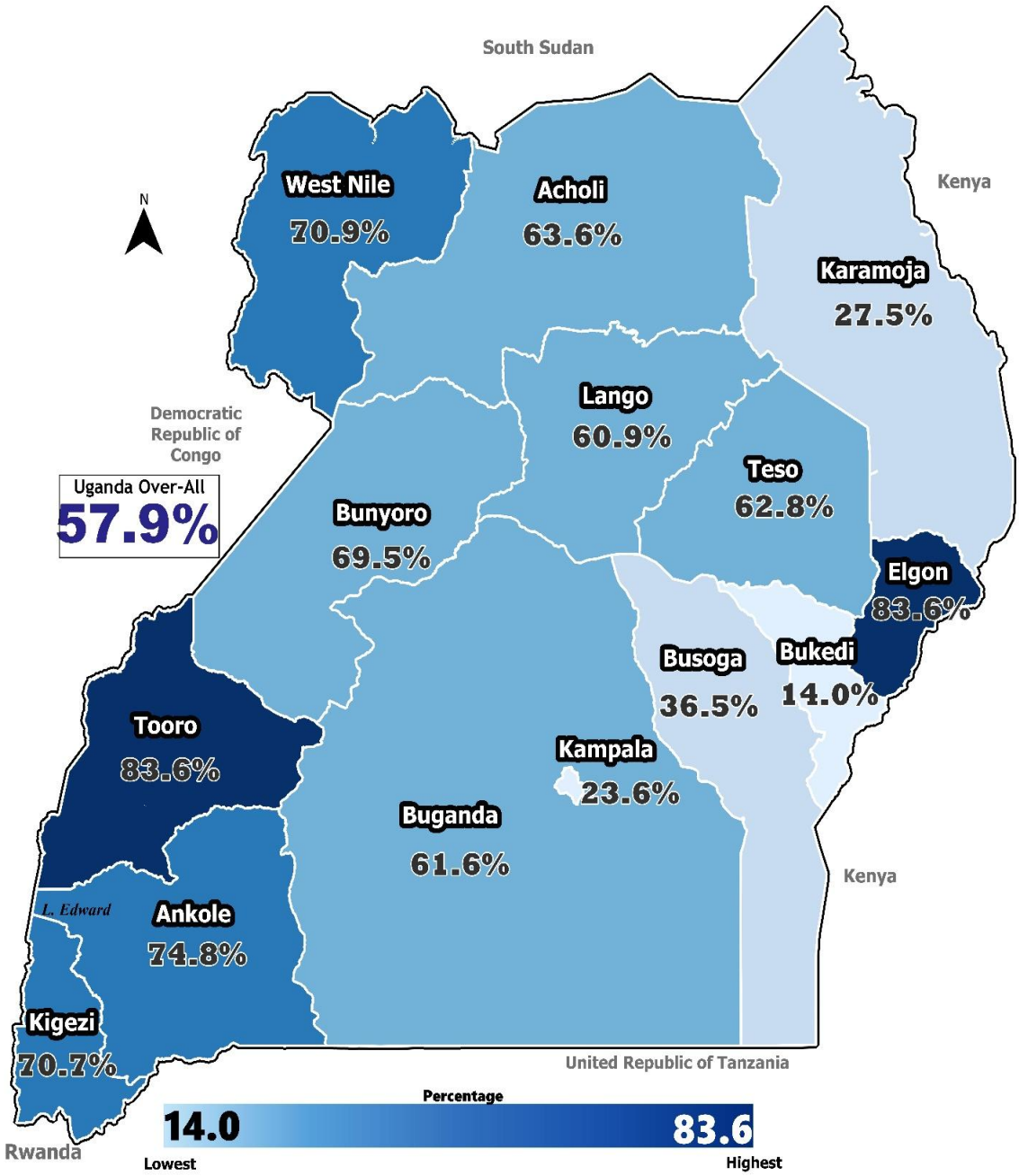


Table 3.5 shows the uneven distribution of water quality among sub regions. Ankole (20.7%) and Kampala (21.6%) sub regions had the highest proportion of households with very low contamination levels of E. coli in their drinking water, likely due to better infrastructure and access to piped water.

In contrast, sub regions such as Lango (61.5%) and Acholi (61.6%) had the highest levels of contamination in their household drinking water, reflecting the challenges faced by rural and less developed areas. These regional disparities align with findings from other studies, which have shown that rural and marginalized regions in sub-Saharan Africa often bear the brunt of poor water quality due to limited investment in water infrastructure (WHO, 2019; Bain et al., 2014).

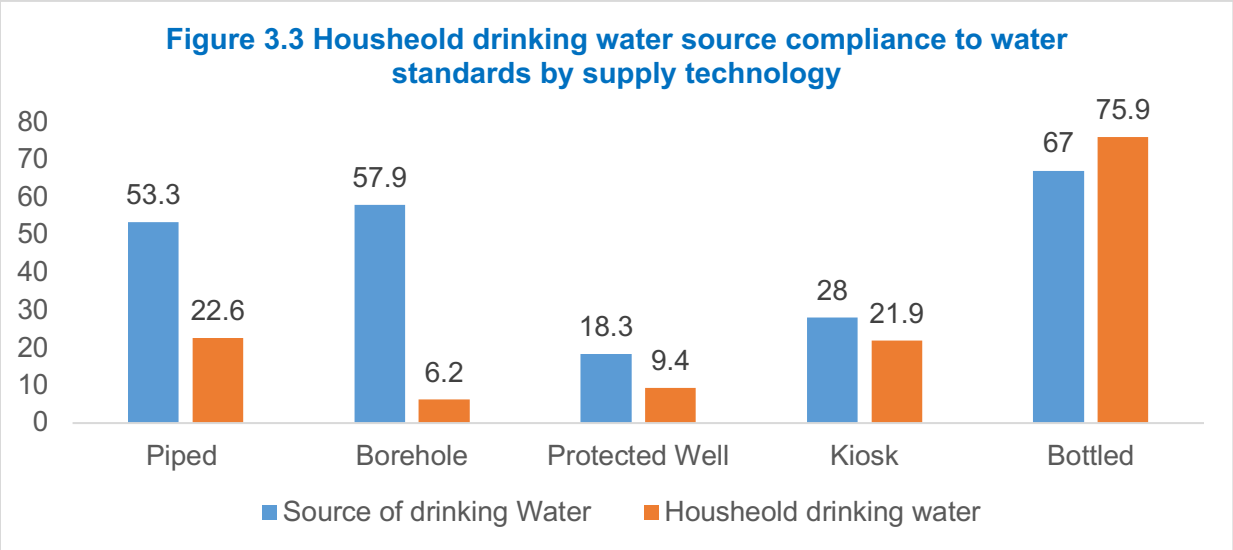
The findings from Uganda are consistent with other studies in sub-Saharan Africa, which have documented high levels of faecal contamination in household drinking water, particularly in rural areas and among poorer populations. For example, a study in Kenya found that 50% of rural households had *E. coli* contamination in their drinking water, compared to 30% in urban areas (Oluwole et al., 2017). Similarly, a study in Nigeria highlighted the role of wealth disparities in access to safe water, with wealthier households being significantly more likely to use improved sources (Adesoji & Farai, 2020). These comparisons emphasize the need for targeted interventions to improve water quality, particularly in rural and low-income settings.

Microbial quality of household drinking water in Uganda is heavily influenced by place of residence, water source type, wealth, and region. Addressing these disparities requires a multifaceted approach, including investment in water infrastructure, water quality testing, promotion of household water treatment, and targeted interventions for rural and low-income populations. Without such efforts, the burden of waterborne diseases will continue to disproportionately affect the most vulnerable communities**.**

3.3 Microbiological water quality and water supply technologies

Drinking water supply technologies are crucial in ensuring access to clean and safe drinking water and they play a vital role in maintaining water quality. Bottled water though used by a limited population had the highest compliance with 67.0% followed by boreholes/tube with 58%. and piped water (53%). Protected wells had the lowest compliance of 18% (Figure 3.3). A difference of 25% in compliance between piped water and kiosk technologies was observed.

This is a concern that needs to be highlighted and investigated to explain the variation. The pattern of increasing contamination from source to household is repeated by water supply technology. The findings align with previous research on water source quality. A study by Bain et al. (2014) found that improved water sources, particularly piped water and tube wells, are associated with lower levels of fecal contamination compared to unimproved sources. Similarly, Shaheed et al. (2014) reported that unprotected wells and surface water are among the most contaminated sources, consistent with the UDHS 2022 data.



The high levels of E. coli contamination in sources (point of collection) and household drinking water (point of use) suggests the widespread challenge of access to safe water, improved hygiene and sanitation to the population of Uganda. A study by Wright et al. (2004) found that contamination often increases between the source and the point of use, particularly in low-income settings where inadequate storage containers and poor hygiene practices are common.

Similarly, Shaheed et al. (2014) reported that household water storage practices, such as using open containers or failing to clean storage vessels, significantly contribute to microbial contamination. The findings agree with the WHO/UNICEF Joint Monitoring Programme (2021), which highlighted that fecal contamination of drinking water was a major public health concern, particularly in sub-Saharan Africa.

The program emphasized improvement in water quality requiring not only access to safe water sources but also interventions at the household level including promoting safe storage and handling practices.

3.4 Microbiological water quality and Time Taken to Collect Water

The results of this survey reveal significant disparities in water quality based on the time households spend accessing water sources, as well as variations across urban-rural divides, wealth quintiles, and regions. Households that spent less than 30 minutes collecting water had lower E. coli contamination levels compared to those that spent 30 minutes or more (Table 3.5). To illustrate this further, 10.1% of households with shorter collection had low contamination levels while 42.5% had very high contamination levels. Households that spent 30 minutes or more had even higher contamination levels as a result only 5.0% had low contamination and 47.5% very high contamination. This therefore suggests that longer water collection times were associated with poorer water quality as a result of increased exposure during transport or storage. The findings compared with previous studies by Graham et al. (2016) highlighted this relationship between water collection time and water quality.

3.5 Microbiological quality by water treatment Practices

The effectiveness of household treatment measures varied by places of residence and across the sub regions of Uganda. The results showed that 35.1% of households that treated water using appropriate water treatment methods experienced a reduction in contamination (Table 3.6) This result was consistent with studies by *Clasen et al. (2015)* affirming that appropriate household water treatment significantly reduces microbial contamination. Households that did not use appropriate treatment methods or took no action reported 65.8% deterioration in drinking water contamination (Table 3.6). These findings are consistent with the studies by *Fewtrell et al. (2005)***,** indicating untreated or inadequately treated household water was a major contributor to diarrheal diseases.

Sub regional disparities in household drinking water contamination were noted across the sub regions of Uganda. Ankole and Buganda sub regions of Uganda reported reduced contamination of 35.6% and 32.4% respectively while Bukedi and Karamoja experienced increased household drinking water contamination of 90.4% and 85.4% respectively (Table 3.6).

The survey results showed that 60.2% of households that practiced water treatment experienced a deterioration in E. coli risk levels, while 22.9% saw no change, and only 16.9% reported improvement *(Table 3.7).* The findings suggest the critical role of household water treatment in reducing microbial contamination or further worsening the situation if not properly handled.

3.6 Microbiological water quality and Wealth Quintiles

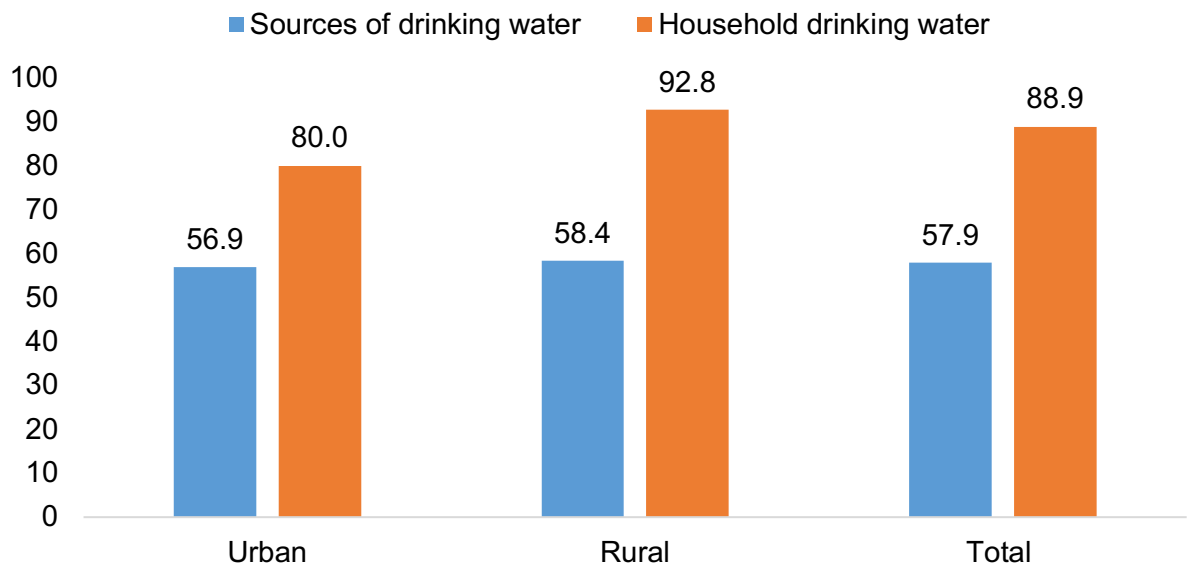
Seventy-two percent (72%) of households in the lowest wealth quintile had high contamination levels in their household drinking water compared to 52.3 % in the highest quintile (Table 3.1). In general, there is a positive correlation between wealth and water quality, meaning wealthier households are more likely to have access to improved drinking water sources. Poor households often rely on unimproved or low water quality sources.

The results of the survey further indicated that Households in the highest wealth quintile reported a 24.9% improvement in E.coli risk levels, compared to only 7.6% in the lowest quintile (Table 3.1). Households in the lowest wealth quintile faced the highest risk, which reflected the unequal distribution of access to safe water sources and sanitation facilities. Bain et al. (2014), in their study noted that wealthier households were more likely to invest in effective water treatment technologies, thereby reducing contamination risks. In contrast, poorer households often rely on untreated or inadequately treated water, exacerbating their vulnerability to waterborne diseases.

3.7 Microbiological water quality risk levels at source and household

In Uganda, 89% of households were at risk of waterborne diseases and illness due to contaminated drinking water (Figure 3.4). By place of residence 80% were in urban areas and 93% in rural places of residence. The risk due to contaminated sources was 58% and by residence 57% of the urban household population and 58% of rural population.

Figure 3.4 Population at risk of water borne diseases as a result of drinking water E.coli contamination, (%)



The results show sub regional disparities for instance, Elgon and Tooro sub regions have the highest risk levels of harmful microorganisms in water sources with 83.6% each.), and these levels remain high at the household level (96.5% and 94.3%, respectively). In contrast, Kampala has the lowest risk levels in both water sources (23.6%) and household drinking water (78.4%), likely due to better infrastructure and access to improved water sources in urban areas (Figure 3.5).

In the West Nile region, 70.9% of households are at risk due to sources contaminated with E. coli, but this further rises to 94.0% at the household level due to hygiene and sanitation practices.This trend is observed across all regions and these findings are consistent with previous studies on fecal contamination in drinking water.

The high levels of fecal contamination in household drinking water, even when source water is relatively safe, stresses the need for targeted interventions to improve water handling and storage practices. Efforts should focus on educating households on proper water storage techniques, providing affordable and safe storage containers, and ensuring regular cleaning of storage vessels. Additionally, improving access to improved water sources, particularly in rural and underserved regions, is critical to reducing contamination at the source.

Figure 3.5 Population at risk to E.coli contamination by Subregion, (%)

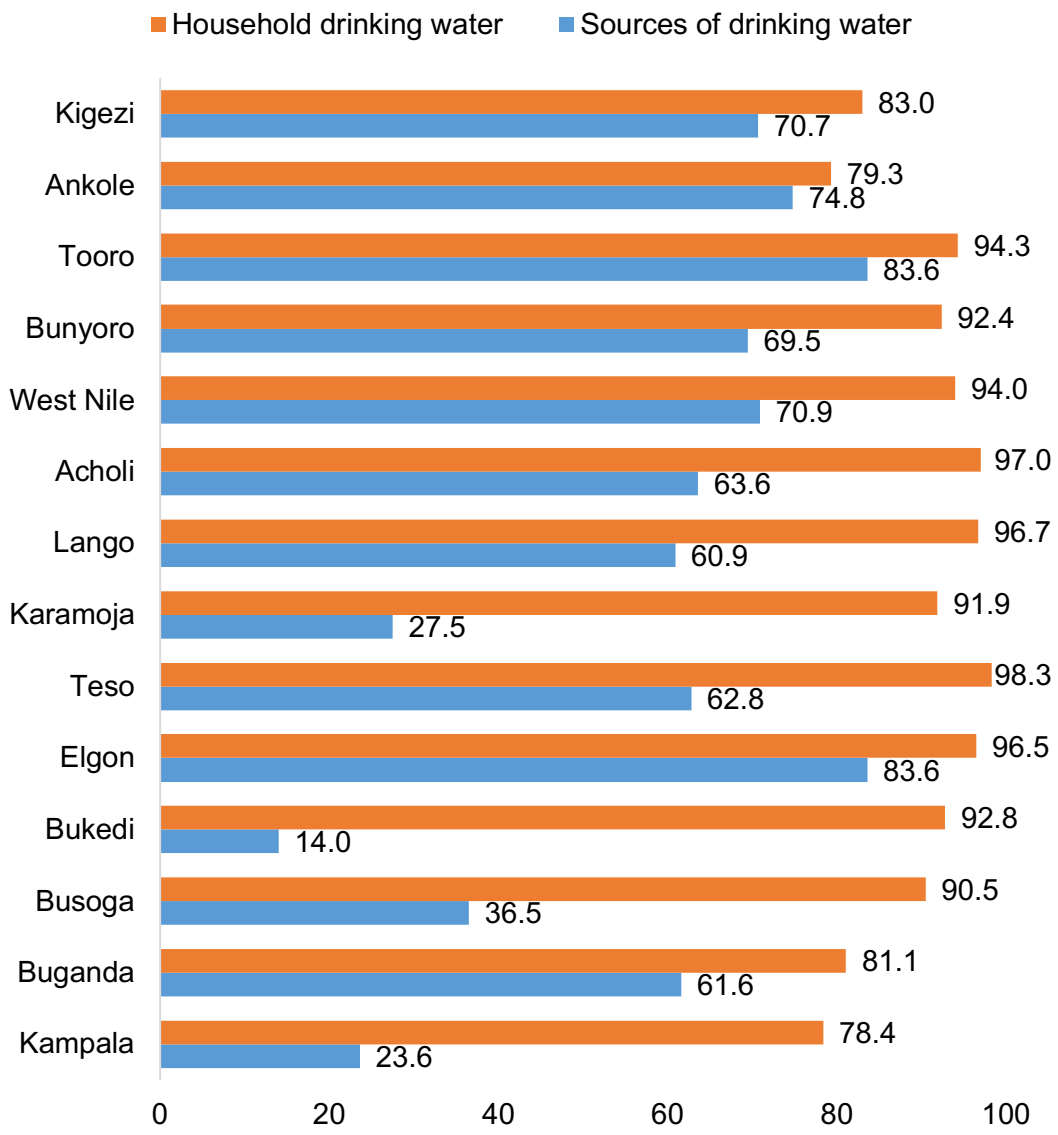


Table: 3.1 Comparison of percentage household water samples that demonstrate reduction in water quality between the source and household drinking water in water quality, UDHS 2022

	Change in E. coli							
	Deteriorated		No Change		Improved		Total	
Characteristic	No.	%	No.	%	No.	%	No.	%
Type of place of residence								
Urban	472.5	51.4	229.7	25.0	216.6	23.6	918.8	100.0
Rural	1,360.7	64.1	466.5	22.0	297.0	14.0	2,124.2	100.0
Wealth index quintile								
Lowest	437.1	71.5	127.5	20.9	46.4	7.6	611.0	100.0
Second	310.8	56.5	157.6	28.6	81.6	14.8	550.0	100.0
Middle	390.7	63.3	150.2	24.3	76.3	12.4	617.3	100.0
Fourth	356.9	57.7	113.5	18.3	148.4	24.0	618.8	100.0
Highest	337.7	52.3	147.5	22.8	160.7	24.9	645.8	100.0
Sub Region								
Kampala	72.8	63.1	25.6	22.2	16.9	14.7	115.2	100.0
Buganda	288.8	42.7	168.6	24.9	219.5	32.4	676.9	100.0
Busoga	242.9	76.7	47.5	15.0	26.4	8.3	316.7	100.0
Bukedi	154.4	90.4	12.5	7.3	4.0	2.3	170.8	100.0
Elgon	82.1	55.4	52.2	35.2	13.8	9.3	148.1	100.0
Teso	197.6	83.3	27.0	11.4	12.7	5.3	237.3	100.0
Karamoja	146.5	85.4	19.5	11.4	5.6	3.3	171.6	100.0
Lango	149.2	68.5	54.3	24.9	14.4	6.6	217.9	100.0
Acholi	78.1	63.9	36.6	29.9	7.5	6.2	122.2	100.0
West Nile	90.1	73.4	23.6	19.2	9.0	7.3	122.7	100.0
Bunyoro	86.0	52.7	49.6	30.4	27.5	16.9	163.1	100.0
Tooro	80.3	41.5	82.2	42.5	30.9	16.0	193.4	100.0
Ankole	111.3	43.1	55.1	21.3	92.0	35.6	258.4	100.0
Kigezi	53.2	41.4	42.0	32.7	33.3	25.9	128.5	100.0
Total	**1,833.2**	**60.2**	**696.3**	**22.9**	**513.5**	**16.9**	**3,043.0**	**100.0**

Table 3.2: Safely managed drinking water services

Percentage of household population with drinking water free from faecal contamination, available when needed, and accessible on premises, for users of improved and unimproved drinking water sources and percentage of household members with an improved drinking water source located on premises, free of E. coli and available when needed, UDHS, 2022

Characteristic	Improved sources				Unimproved sources							Number of HH members
	Without E. coli in drinking water source	With drinking water available in sufficient quantities	Drinking water accessible on premises	Number of household members with information on water quality who are using improved sources	Without E. coli in drinking water source	With drinking water available in sufficient quantities	Drinking water accessible on premises	Number of household members with information on water quality who are using unimproved sources	Percentage of household members with an improved drinking water source located on premises, free of E. coli and available when needed [1]	Number of households	Number of household members with information on water quality	
Total	**49.6**	**68.3**	**15.8**	**11263**	**8.2**	**61.3**	**2.9**	**2502**	**5.2**	**N=3042**	**13765**	**N=13858**
Type of place of residence												
Urban	47.2	68.3	31.3	3749	9.2	61.4	2.1	444	11.4	N=1013	4193	N=4306
Rural	50.8	68.4	8.1	7514	8.0	61.3	3.1	2058	2.5	N=2029	9572	N=9552
Main source of drinking water [A]												
Improved sources	50.3	67.9	13.8	10890	-	-	-	-	6.1	N=2502	10890	N=11342
Piped water	53.3	68.7	38.5	2877	-	-	-	-	16.5	N=714	2877	N=2902
Tubewell/Borehole	57.9	65.2	4.3	6058	-	-	-	-	2.1	N=1308	6058	N=6373
Protected well or spring	18.3	75.2	4.6	1810	-	-	-	-	1.3	N=412	1810	N=1926
Bottled water	73.4	75.9	37.0	145	-	-	-	-	25.9	N=68	145	N=141
Unimproved sources	28.5	80.8	74.5	373	8.2	61.3	2.9	2502	2.0	N=540	2875	N=2516
Unprotected well or spring	-	-	-	-	8.8	56.8	2.9	1358	0.0	N=251	1358	N=1181
Surface water	-	-	-	-	7.4	66.8	2.6	1140	0.0	N=214	1140	N=1016
Rainwater	28.0	83.9	81.8	302	-	-	-	-	18.6	N=55	302	N=249
Wealth index quintile												
Lowest	54.1	62.3	2.0	2230	9.9	59.9	0.8	518	0.8	N=710	2747	N=3036
Second	42.7	66.6	4.5	1867	5.2	58.3	3.4	604	1.1	N=560	2470	N=2663
Middle	48.0	69.9	7.1	2128	2.4	69.7	2.1	580	2.4	N=515	2708	N=2628
Fourth	44.8	63.1	15.7	2187	17.4	57.4	4.0	620	4.2	N=570	2807	N=2670
Highest	55.4	77.0	40.6	2852	0.2	61.7	6.3	180	16.0	N=687	3032	N=2861
Sub Region												
Kampala	77.1	72.9	35.7	518	0.0	71.7	71.7	5	23.5	N=201	523	N=722
Buganda	48.6	72.4	28.7	2386	9.7	53.6	1.7	845	8.8	N=458	3231	N=1947
Busoga	67.0	54.9	5.8	1315	2.3	16.7	0.0	76	1.7	N=278	1391	N=1444
Bukedi	86.8	85.2	11.8	784	32.5	32.5	0.0	11	10.0	N=176	794	N=921
Elgon	17.2	74.0	5.0	573	11.4	88.3	2.7	97	1.8	N=182	670	N=824
Teso	37.8	51.4	4.9	959	0.0	0.0	0.0	15	1.3	N=190	975	N=1063
Karamoja	76.0	52.5	2.5	716	28.1	54.1	0.0	56	0.1	N=167	772	N=694
Lango	45.7	65.3	9.4	780	7.3	49.8	0.0	161	1.4	N=209	941	N=994
Acholi	49.7	51.3	5.9	397	0.0	79.1	5.2	145	1.0	N=181	542	N=762
West Nile	33.4	57.8	11.3	452	5.9	52.7	1.5	85	1.7	N=221	536	N=1059
Bunyoro	35.4	84.1	10.6	639	6.2	83.4	7.9	130	2.9	N=195	769	N=838
Tooro	23.9	70.8	22.8	600	5.5	65.0	3.2	408	3.0	N=188	1008	N=905
Ankole	31.5	89.1	27.6	740	9.5	73.5	3.1	295	7.9	N=224	1035	N=945
Kigezi	38.1	77.1	23.0	403	8.9	66.7	6.0	174	4.0	N=172	577	N=740

Table 3.3a: Quality of source drinking water Percent distribution and percentage of household population at risk of faecal contamination based on number of E. coli detected in source drinking water, UDHS 2022

Characteristic	Risk level based on number of E. coli per 100 mL					Percentage of household population with E. coli in source water [1]	Number of households	Number of household members	Number of HH members
	Low (<1 per 100 mL)	Moderate (1-10 per 100 mL)	High (11-100 per 100 mL)	Very high (>100 per 100 mL)	Total				
Total	**42.1**	**17.7**	**17.7**	**22.5**	**100.0**	**57.9**	**N=3042**	**13765**	**N=13858**
Type of place of residence									
Urban	43.1	17.1	20.3	19.5	100.0	56.9	N=1013	4193	N=4306
Rural	41.6	18.0	16.6	23.8	100.0	58.4	N=2029	9572	N=9552
Main source of drinking water [A]									
Improved sources	50.3	20.1	16.9	12.7	100.0	49.7	N=2502	10890	N=11342
Piped water	53.3	20.8	15.9	9.9	100.0	46.7	N=714	2877	N=2902
Tubewell/Borehole	57.9	18.4	14.6	9.2	100.0	42.1	N=1308	6058	N=6373
Protected well or spring	18.3	26.0	26.7	29.1	100.0	81.7	N=412	1810	N=1926
Bottled water	73.4	5.0	9.5	12.1	100.0	26.6	N=68	145	N=141
Unimproved sources	10.8	8.7	21.0	59.6	100.0	89.2	N=540	2875	N=2516
Unprotected well or spring	8.8	9.3	20.9	61.0	100.0	91.2	N=251	1358	N=1181
Tanker-truck/Bicycle with jerrycan	(*)	(*)	(*)	(*)	100.0	67.6	N=12	48	N=40
Surface water	7.4	4.1	17.8	70.6	100.0	92.6	N=214	1140	N=1016
Rainwater	28.0	24.2	22.7	25.0	100.0	72.0	N=55	302	N=249
Sachet water	(*)	(*)	(*)	(*)	100.0	73.0	N=6	23	N=25
Other	(*)	(*)	(*)	(*)	100.0	90.2	N=2	4	N=5
Wealth index quintile									
Lowest	45.8	16.6	16.4	21.2	100.0	54.2	N=710	2747	N=3036
Second	33.6	16.9	17.3	32.2	100.0	66.4	N=560	2470	N=2663
Middle	38.2	17.4	18.6	25.7	100.0	61.8	N=515	2708	N=2628
Fourth	38.8	20.0	19.1	22.2	100.0	61.2	N=570	2807	N=2670
Highest	52.1	17.6	17.2	13.1	100.0	47.9	N=687	3032	N=2861
Sub Region									
Kampala	76.4	7.8	9.4	6.4	100.0	23.6	N=201	523	N=722
Buganda	38.4	16.8	17.9	26.8	100.0	61.6	N=458	3231	N=1947
Busoga	63.5	14.1	13.3	9.2	100.0	36.5	N=278	1391	N=1444
Bukedi	86.0	11.0	2.8	0.1	100.0	14.0	N=176	794	N=921
Elgon	16.4	24.1	23.9	35.7	100.0	83.6	N=182	670	N=824
Teso	37.2	32.6	17.9	12.3	100.0	62.8	N=190	975	N=1063
Karamoja	72.5	9.6	9.1	8.9	100.0	27.5	N=167	772	N=694
Lango	39.1	14.2	19.3	27.4	100.0	60.9	N=209	941	N=994
Acholi	36.4	22.0	12.2	29.4	100.0	63.6	N=181	542	N=762
West Nile	29.1	25.2	28.5	17.2	100.0	70.9	N=221	536	N=1059
Bunyoro	30.5	26.2	13.2	30.1	100.0	69.5	N=195	769	N=838
Tooro	16.4	13.0	20.8	49.8	100.0	83.6	N=188	1008	N=905
Ankole	25.2	18.0	34.2	22.6	100.0	74.8	N=224	1035	N=945
Kigezi	29.3	19.4	23.0	28.3	100.0	70.7	N=172	577	N=740

[1] MICS indicator WS.4 - Faecal contamination of source water

[A] As collected in the Household Questionnaire; may be different than the source drinking water tested

Table 3.3b: Quality of household drinking water
Percent distribution and percentage of household population at risk of faecal contamination based on number of E. coli detected in household drinking water, DHS Uganda, 2022

Characteristic	Risk level based on number of E. coli per 100 mL					Percentage of household population with E. coli in household drinking water [1]	Number of households	Number of household members	Number of HH members
	Low (<1 per 100 mL)	Moderate (1-10 per 100 mL)	High (11-100 per 100 mL)	Very high (>100 per 100 mL)	Total				
Total	**11.1**	**19.0**	**29.0**	**40.9**	**100.0**	**88.9**	**N=3110**	**14215**	**N=14140**
Type of place of residence									
Urban	20.0	21.7	27.7	30.6	100.0	80.0	N=1042	4340	N=4420
Rural	7.2	17.8	29.5	45.5	100.0	92.8	N=2068	9875	N=9720
Main source of drinking water [A]									
Improved sources	12.1	19.8	31.1	37.0	100.0	87.9	N=2547	11240	N=11507
Piped water	22.6	21.9	28.4	27.2	100.0	77.4	N=724	2895	N=2950
Tubewell/Borehole	6.2	19.7	34.3	39.7	100.0	93.8	N=1327	6263	N=6444
Protected well or spring	9.4	18.8	26.0	45.8	100.0	90.6	N=421	1901	N=1959
Bottled water	76.6	2.6	13.6	7.2	100.0	23.4	N=75	181	N=154
Unimproved sources	7.3	15.8	21.1	55.8	100.0	92.7	N=563	2975	N=2633
Unprotected well or spring	6.2	15.3	22.4	56.1	100.0	93.8	N=254	1398	N=1194
Tanker-truck/Bicycle with jellycan	(*)	(*)	(*)	(*)	100.0	91.6	N=12	46	N=40
Surface water	2.7	12.0	16.3	69.1	100.0	97.3	N=226	1154	N=1084
Rainwater	21.9	23.6	34.3	20.2	100.0	78.1	N=63	343	N=285
Sachet water	(*)	(*)	(*)	(*)	100.0	28.2	N=6	29	N=25
Other	(*)	(*)	(*)	(*)	100.0	89.6	N=2	4	N=5
Wealth index quintile									
Lowest	3.9	12.9	30.8	52.3	100.0	96.1	N=719	2816	N=3075
Second	5.7	15.9	26.8	51.6	100.0	94.3	N=578	2597	N=2754
Middle	7.6	14.4	28.1	49.9	100.0	92.4	N=524	2857	N=2663
Fourth	12.7	22.2	32.2	32.9	100.0	87.3	N=584	2913	N=2730
Highest	24.2	28.5	26.8	20.5	100.0	75.8	N=705	3032	N=2918
Sub Region									
Kampala	21.6	22.2	31.3	24.8	100.0	78.4	N=204	516	N=728
Buganda	18.9	30.3	25.4	25.4	100.0	81.1	N=474	3315	N=2006
Busoga	9.5	24.7	32.6	33.2	100.0	90.5	N=280	1422	N=1448
Bukedi	7.2	18.6	39.8	34.4	100.0	92.8	N=176	783	N=921
Elgon	3.5	12.3	29.0	55.2	100.0	96.5	N=187	674	N=843
Teso	1.7	8.8	33.3	56.1	100.0	98.3	N=194	1110	N=1088
Karamoja	8.1	11.4	31.8	48.6	100.0	91.9	N=167	778	N=694
Lango	3.3	8.8	26.4	61.5	100.0	96.7	N=210	979	N=999
Acholi	3.0	11.2	23.8	61.9	100.0	97.0	N=184	550	N=768
West Nile	6.0	5.5	30.6	57.9	100.0	94.0	N=221	556	N=1059
Bunyoro	7.6	21.2	19.6	51.7	100.0	92.4	N=197	749	N=851
Tooro	5.7	12.2	23.2	59.0	100.0	94.3	N=212	1008	N=1013
Ankole	20.7	21.3	37.0	20.9	100.0	79.3	N=230	1181	N=976
Kigezi	17.0	17.2	25.3	40.4	100.0	83.0	N=174	591	N=746

[1] MICS indicator WS.5 - Faecal contamination of household drinking water
[A] As collected in the Household Questionnaire; may be different than the source drinking water tested

Table 3.4: Quality of source drinking water Lead as Pb (mg/L))
Percent distribution and percentage of household population at risk of exposure Lead as Pb (mg/L) detected in source drinking water, UDHS Uganda, 2022

		Chemical:						
		Lead as Pb (mg/L)[I]						
Characteristic	household population with E. coli in source water [1]	Low risk, Acceptable	High risk, Not Acceptable	Total	Number of tests administered	Number of households	Number of household members	Number of HH members
Total	**57.9**	**72.3**	**27.7**	**100.0**	**N=794**	**N=3042**	**13765**	**N=13858**
Type of place of residence								
Urban	56.9	78.2	21.8	100.0	N=338	N=1013	4193	N=4306
Rural	58.4	68.3	31.7	100.0	N=456	N=2029	9572	N=9552
Main source of drinking water [A]								
Improved sources	49.7	73.2	26.8	100.0	N=620	N=2502	10890	N=11342
Piped water	46.7	73.5	26.5	100.0	N=244	N=714	2877	N=2902
Tubewell/Borehole	42.1	71.1	28.9	100.0	N=259	N=1308	6058	N=6373
Protected well or spring	81.7	77.4	22.6	100.0	N=104	N=412	1810	N=1926
Unimproved sources	89.2	69.9	30.1	100.0	N=174	N=540	2875	N=2516
Unprotected well or spring	91.2	72.5	27.5	100.0	N=101	N=251	1358	N=1181
Surface water	92.6	62.5	37.5	100.0	N=53	N=214	1140	N=1016
Wealth index quintile								
Lowest	54.2	51.7	48.3	100.0	N=140	N=710	2747	N=3036
Second	66.4	70.2	29.8	100.0	N=142	N=560	2470	N=2663
Middle	61.8	74.8	25.2	100.0	N=118	N=515	2708	N=2628
Fourth	61.2	69.0	31.0	100.0	N=150	N=570	2807	N=2670
Highest	47.9	82.5	17.5	100.0	N=244	N=687	3032	N=2861

[1] MICS indicator WS.4 - Faecal contamination of source water
[I] Lead as Pb (mg/L): Urban: Lead <= 0.010, Low risk, Acceptable; Lead >= 0.011, High risk, Not Acceptable; and Rural: Lead <= 0.010, Low risk, Acceptable; Lead >= 0.011, High risk, Not Acceptable.
N=Unweighted cases

Table: 3.5 Household E.coli contamination levels by time taken to water sources Less than 30mins or more than 30 mins, UDHS 2022

Characteristic	1. low<1		2. Intermediate 1-10		3. High 11-100		4. Very high>100		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
Type of place of residence										
Urban	190.1	20.0	205.7	21.6	263.8	27.7	291.0	30.6	950.5	100.0
Rural	155.5	7.2	385.5	17.8	638.4	29.5	984.1	45.5	2,163.5	100.0
Wealth index quintile										
Lowest	24.3	3.9	79.7	12.9	190.0	30.8	322.4	52.3	616.4	100.0
Second	32.4	5.7	90.5	15.9	152.2	26.8	293.4	51.6	568.5	100.0
Middle	47.4	7.6	90.1	14.4	176.3	28.1	313.4	50.0	627.1	100.0
Fourth	80.7	12.6	141.7	22.2	205.6	32.2	210.2	32.9	638.2	100.0
Highest	160.8	24.2	189.1	28.5	178.1	26.8	135.8	20.5	663.8	100.0
Sub Region										
Kampala	24.5	21.6	25.1	22.2	35.4	31.3	28.1	24.8	113.0	100.0
Buganda	137.5	18.9	219.9	30.3	184.1	25.4	184.3	25.4	725.7	100.0
Busoga	29.6	9.5	77.0	24.7	101.4	32.6	103.3	33.2	311.3	100.0
Bukedi	12.3	7.2	32.0	18.6	68.2	39.8	59.0	34.4	171.5	100.0
Elgon	5.1	3.5	18.1	12.3	42.8	29.0	81.6	55.2	147.6	100.0
Teso	4.2	1.7	21.5	8.8	81.0	33.2	137.5	56.3	244.2	100.0
Karamoja	13.8	8.1	19.4	11.4	54.3	31.8	82.9	48.6	170.4	100.0
Lango	7.0	3.3	18.8	8.8	56.6	26.4	131.8	61.5	214.3	100.0
Acholi	3.6	3.0	13.5	11.1	29.5	24.3	74.9	61.6	121.5	100.0
West Nile	7.3	6.0	6.7	5.5	37.3	30.6	70.5	57.9	121.8	100.0
Bunyoro	12.4	7.6	34.8	21.2	32.1	19.6	84.8	51.7	164.0	100.0
Tooro	12.6	5.7	26.9	12.2	51.1	23.2	130.1	59.0	220.7	100.0
Ankole	53.6	20.7	55.1	21.3	95.8	37.1	54.1	20.9	258.6	100.0
Kigezi	22.1	17.0	22.3	17.2	32.7	25.3	52.3	40.4	129.4	100.0
Time to water source and back (mins)										
Less than 30 mins	112.1	10.1	198.1	17.8	328.2	29.6	472.1	42.5	1,110.6	100.0
30 mins/more	61.9	5.0	211.2	17.2	373.2	30.3	584.0	47.5	1,230.4	100.0
Total	**174.1**	**7.4**	**409.4**	**17.5**	**701.4**	**30.0**	**1,056.1**	**45.1**	**2,341.0**	**100.0**

Table: 3.6 Change in E.coli risk levels between the source & household by treatment practices, UDHS 2022

Characteristic	Change in E. coli							
	Deteriorated		No Change		Improved		Total	
	No.	%	No.	%	No.	%	No.	%
Type of place of residence								
Urban	472.5	51.4	229.7	25.0	216.6	23.6	918.8	100
Rural	1,360.7	64.1	466.5	22.0	297.0	14.0	2,124.2	100
Wealth index quintile								
Lowest	437.1	71.5	127.5	20.9	46.4	7.6	611.0	100.0
Second	310.8	56.5	157.6	28.6	81.6	14.8	550.0	100.0
Middle	390.7	63.3	150.2	24.3	76.3	12.4	617.3	100.0
Fourth	356.9	57.7	113.5	18.3	148.4	24.0	618.8	100.0
Highest	337.7	52.3	147.5	22.8	160.7	24.9	645.8	100.0
Appropriate water Treatment								
Appropriate	373.8	45.2	162.8	19.7	289.8	35.1	826.5	100.0
Others (Includes In-appropriated and Did Nothing/No treatment)	1,459.4	65.8	533.5	24.1	223.7	10.1	2,216.5	100.0
Sub Region								
Kampala	72.8	63.1	25.6	22.2	16.9	14.7	115.2	100.0
Buganda	288.8	42.7	168.6	24.9	219.5	32.4	676.9	100.0
Busoga	242.9	76.7	47.5	15.0	26.4	8.3	316.7	100.0
Bukedi	154.4	90.4	12.5	7.3	4.0	2.3	170.8	100.0
Elgon	82.1	55.4	52.2	35.2	13.8	9.3	148.1	100.0
Teso	197.6	83.3	27.0	11.4	12.7	5.3	237.3	100.0
Karamoja	146.5	85.4	19.5	11.4	5.6	3.3	171.6	100.0
Lango	149.2	68.5	54.3	24.9	14.4	6.6	217.9	100.0
Acholi	78.1	63.9	36.6	29.9	7.5	6.2	122.2	100.0
West Nile	90.1	73.4	23.6	19.2	9.0	7.3	122.7	100.0
Bunyoro	86.0	52.7	49.6	30.4	27.5	16.9	163.1	100.0
Tooro	80.3	41.5	82.2	42.5	30.9	16.0	193.4	100.0
Ankole	111.3	43.1	55.1	21.3	92.0	35.6	258.4	100.0
Kigezi	53.2	41.4	42.0	32.7	33.3	25.9	128.5	100.0
Total	**1,833.2**	**60.2**	**696.3**	**22.9**	**513.5**	**16.9**	**3,043.0**	**100.0**

Table: 3.7 Change in E.coli risk levels between the source and household that practiced water treatment, UDHS 2022

Characteristic	Deteriorated		No Change		Improved		Total	
	No.	%	No.	%	No.	%	No.	%
Type of place of residence								
Urban	472.5	51.4	229.7	25.0	216.6	23.6	918.8	100.0
Rural	1,360.7	64.1	466.5	22.0	297.0	14.0	2,124.2	100.0
Wealth index quintile								
Lowest	437.1	71.5	127.5	20.9	46.4	7.6	611.0	100.0
Second	310.8	56.5	157.6	28.6	81.6	14.8	550.0	100.0
Middle	390.7	63.3	150.2	24.3	76.3	12.4	617.3	100.0
Fourth	356.9	57.7	113.5	18.3	148.4	24.0	618.8	100.0
Highest	337.7	52.3	147.5	22.8	160.7	24.9	645.8	100.0
Sub Region								
Kampala	72.8	63.1	25.6	22.2	16.9	14.7	115.2	100.0
Buganda	288.8	42.7	168.6	24.9	219.5	32.4	676.9	100.0
Busoga	242.9	76.7	47.5	15.0	26.4	8.3	316.7	100.0
Bukedi	154.4	90.4	12.5	7.3	4.0	2.3	170.8	100.0
Elgon	82.1	55.4	52.2	35.2	13.8	9.3	148.1	100.0
Teso	197.6	83.3	27.0	11.4	12.7	5.3	237.3	100.0
Karamoja	146.5	85.4	19.5	11.4	5.6	3.3	171.6	100.0
Lango	149.2	68.5	54.3	24.9	14.4	6.6	217.9	100.0
Acholi	78.1	63.9	36.6	29.9	7.5	6.2	122.2	100.0
West Nile	90.1	73.4	23.6	19.2	9.0	7.3	122.7	100.0
Bunyoro	86.0	52.7	49.6	30.4	27.5	16.9	163.1	100.0
Tooro	80.3	41.5	82.2	42.5	30.9	16.0	193.4	100.0
Ankole	111.3	43.1	55.1	21.3	92.0	35.6	258.4	100.0
Kigezi	53.2	41.4	42.0	32.7	33.3	25.9	128.5	100.0
Total	**1,833.2**	**60.2**	**696.3**	**22.9**	**513.5**	**16.9**	**3,043.0**	**100.0**

Table 3.8 Change in Source to Household E. coli in respect to drinking water container type

Water Storage Container	Change in E. coli							
	Deteriorated		No Change		Improved		Total	
	No.	%	No.	%	No.	%	No.	%
1. Direct from source	95.8	46.8	62.3	30.4	46.7	22.8	**204.8**	**100**
2. Covered container	981	63.7	315.6	20.5	244.2	15.8	**1,540.8**	**100**
3. Uncovered container	708.1	58.4	304.3	25.1	199.9	16.5	**1,212.4**	**100**
4. Unable to observe	48.3	56.8	14.0	16.5	22.7	26.7	**85.0**	**100**
Total	**1,833.2**	**60.2**	**696.3**	**22.9**	**513.5**	**16.9**	**3,043.0**	**100**

Table 3.9 Change in E. coli risk levels between the source and household by availability of hand washing facilities, The UDHS2022

Observed place for handwashing	Change in E. coli							
	Deteriorated		No Change		Improved		Total	
	No.	%	No.	%	No.	%	No.	%
Handwashing Facility observed	698.2	55.4	329.3	26.1	233.4	18.5	1,261.0	100
No handwashing facility	1,134.5	63.7	366.6	20.6	279.9	15.7	1,781.0	100
Total	**1,832.7**	**60.2**	**695.9**	**22.9**	**513.4**	**16.9**	**3,042.0**	**100**

Table 3.10 Change in E. coli risk levels between the source and household by availability of hand washing facilities, The UDHS2022

Appropriate water Treatment	Change in E. coli							
	Deteriorated		No Change		Improved		Total	
	No.	%	No.	%	No.	%	No.	%
1. Appropriate	373.8	45.2	162.8	19.7	289.8	35.1	826.5	100
2. Others (Includes In-appropriated and Did Nothing/No treatment)	1,459.4	65.8	533.5	24.1	223.7	10.1	2,216.5	100
Total	1,833.2	60.2	696.3	22.9	513.5	16.9	3,043.0	100

CHAPTER 4: CHEMICAL WATER QUALITY

Chemical water quality refers to the concentration of dissolved minerals, chemicals and other substances which can significantly impact its suitability for drinking purposes as specified in the potable water standards (DEAS 2018) and the WHO guidelines.

The priority chemicals in drinking water quality under this survey are substances that pose significant health risks and frequently found in water sources. They include arsenic, fluoride, nitrate and lead.

4.1 Priority chemical substances in drinking water, sources and health implications

Chemical exposure through drinking water can significantly impact human health leading to short term and long-term effects. Exposure to high doses of chemicals in drinking water may lead to short term health effects such as skin rashes, nervous system or organ damage, development or reproductive effects. Exposure to lower doses over a long period of time may result in chronic effects such as cancer and death.

4.1.1 Arsenic

Arsenic-contaminated drinking-water risks populations to acute toxicity of arsenic compounds due to its low rate of removal from the body. Contaminated water used for drinking; food preparation and irrigation of food crops poses the greatest threat to public health from Arsenic. Long-term exposure to Arsenic from drinking-water and food can cause cancer and skin lesions. It has also been associated with cardiovascular disease and diabetes.

Arsenic has not been demonstrated to be essential in humans. The acute toxicity of Arsenic compounds in humans is predominantly a function of their rate of removal from the body. Signs of chronic Arsenicism, including dermal lesions such as hyperpigmentation and hypo-pigmentation, peripheral neuropathy, skin cancer, bladder and lung cancers and peripheral vascular disease, have been observed in populations ingesting Arsenic-contaminated drinking-water.

4.1.2 Fluoride

Fluoride concentrations above 1.5 mg/l carry an increasing risk of dental fluorosis and that progressively higher concentrations lead to increasing risks of skeletal fluorosis. Fluoride is a naturally occurring mineral to which the public are often exposed via drinking-water. Depending on dose intake fluoride may have both beneficial effects (reducing the incidence of dental caries) or negative effects. Traces of fluorides are present in many waters, with higher concentrations often associated with groundwaters. Fluorides are widely used in dental preparations (mouthwashes, toothpaste) to combat dental caries.

4.1.3 Lead

Lead exposure is associated with a wide range of effects, including various neuro-developmental effects, mortality (mainly due to cardiovascular diseases), impaired renal function, hypertension, impaired fertility and adverse pregnancy outcomes. Lead is present in tap water primarily from corrosive water effects on household plumbing systems containing lead in pipes, solder or fittings, or from the service connections to homes. Lead concentrations in drinking-water are generally below 5 µg/l, although much higher concentrations (above 100 µg/l) have been measured where lead service connections or fittings are present. The primary source of lead is from service connections and plumbing in buildings; therefore, lead should be measured at the tap. Lead concentrations can also vary according to the period in which the water has been in contact with the lead-containing materials.

4.1.4 Nitrates

Consuming nitrate in drinking water above 50 mg/l can cause blue baby syndrome in infants, a health condition also known as methemoglobinemia. This serious condition can occur when nitrate in drinking water is converted to nitrite in an infant's gut. This nitrite interferes with oxygen transport, causing the skin to turn blue. Nitrate levels vary significantly, but levels in well water are often higher than those in surface water and, unless heavily influenced by surface water, are less likely to fluctuate.

4.2 Chemical water quality testing response rates

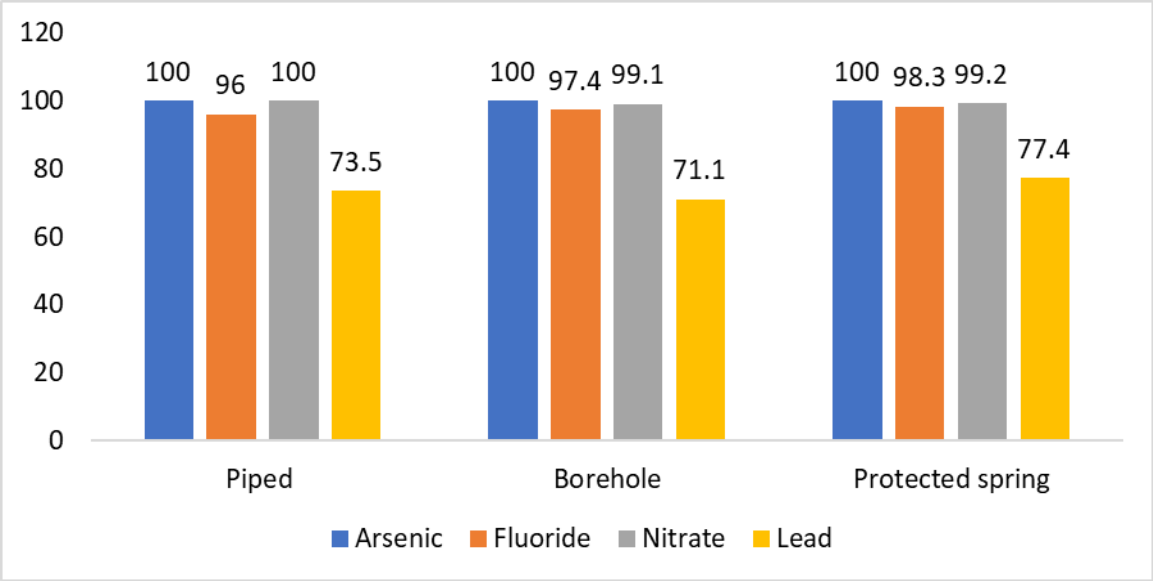
Chemical Water quality testing in the survey for arsenic, fluoride, nitrates and lead contamination was primarily on household drinking water sources. Out of the 3,078 drinking water source samples collected 872 source samples were tested for arsenic contamination representing 28 percent of water quality testing response rate. The water quality testing response rates and number of samples tested for fluoride, nitrates and lead were 2,570 (84%), 2,403 (78%) and 848 (28%) respectively.

The chemical water quality testing rates are below the 95% response rates achieved in the microbiological water quality testing for nationally representative household surveys. This approach is consistent with study by Bain et al (2021) in the article monitoring drinking water quality in nationally representative household surveys in low- and middle-income countries. For the purposes of this report chemical water quality is used to provide situational analysis and emphasize the need to scale up.

4.3 Chemical contamination risk levels in drinking water Sources

All the source drinking water tested during the survey had low risk (acceptable) with respect to priority chemicals as follows: arsenic (98%), fluoride (98%), nitrate (99.5%), and lead (72%). Details are presented in Tables 4.1, 4.2, 4.3 & 4.4. Generally, the priority chemical exposure levels in sources drinking water were low with respect to arsenic, fluorides, nitrates except for lead *(Figure 4.1).*

Figure 4.1 Percent compliance of source drinking water to priority chemical standards by technology

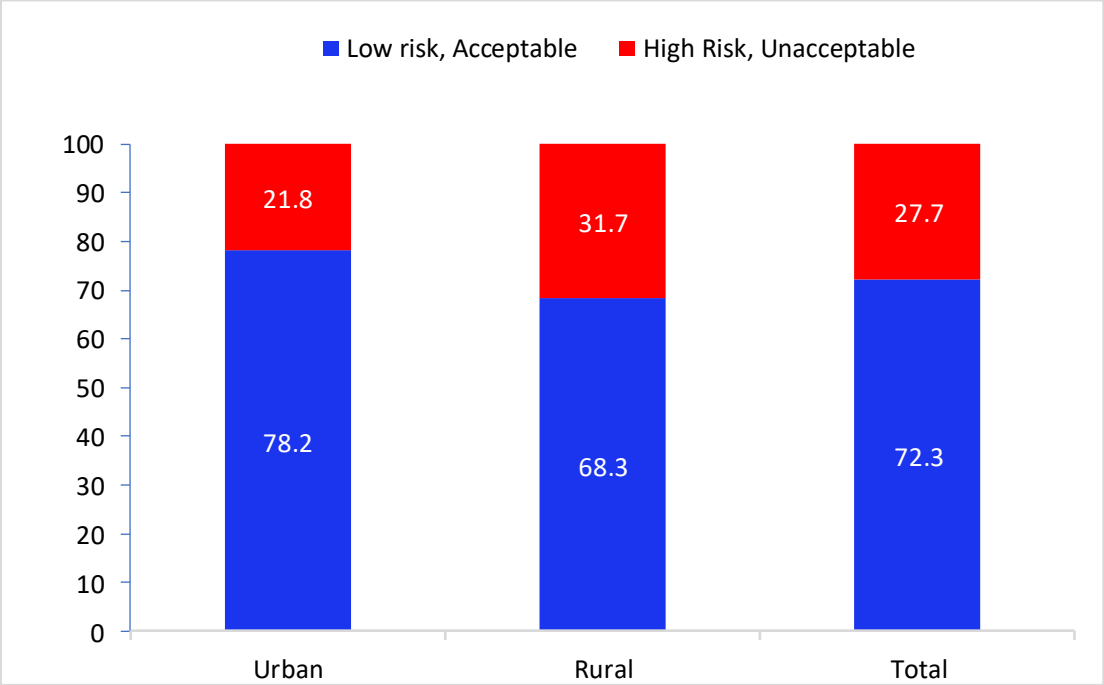


4.4 Lead risk levels in drinking water sources by places of residence

Generally, the chemical exposure levels in drinking water sources were low with respect to arsenic, fluorides, nitrates except for lead. The lead contamination, Figure 4.2, in source drinking water had a 10-percentage point difference between rural (32%) and urban (22%) which is a concern that needs urgent investigations given the health significance and far-reaching implications in children and reproductive women.

It is also important to state that due to the low chemical water quality testing rates (28%) during the survey it was not possible to stretch the analysis further to the regional perspectives and wealth quintiles.

Figure 4.2 Lead exposure and risk levels per tested samples in Urban and rural places of residence



4.4 Chemical lead risk levels in drinking water sources by water supply technologies

The survey finding on chemical lead risk levels by common water supply technologies (Figure 4.3) suggests a low-risk gradient from protected springs (77%), piped system (73%) and boreholes (71%). The results indicate the primary source of lead is from service connections and plumbing or the period in which the water has been in contact with the lead-containing materials. For the case of protected springs, the materials used and contact time are minimal. Piped water systems contain more service connections and plumbing as compared to boreholes. However, the contact time is more in boreholes and compared to piped systems. See Table 4.5 for details.

Figure 4.3 Lead exposure and risk levels in improved sources

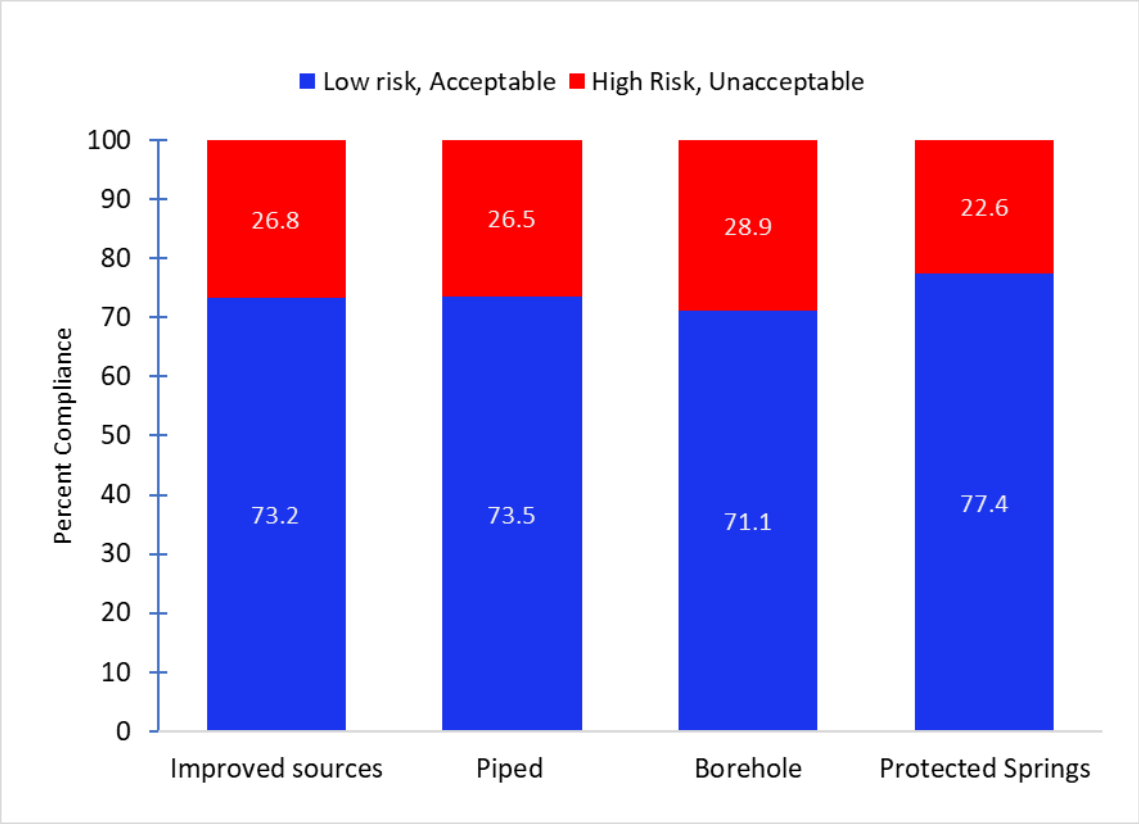


Table 4.1: Quality of source drinking water Arsenic as As (mg/L))
Percent distribution and percentage of household population at risk of exposure Arsenic as As (mg/L) detected in source drinking water, UDHS 2022

Characteristic	Chemical: Arsenic as As (mg/L)[H]					
	Low risk, Acceptable	Total				
Total	**100.0**	**100.0**	**N=817**	**N=3042**	**13765**	**N=13858**
Type of place of residence						
Urban	100.0	100.0	N=343	N=1013	4193	N=4306
Rural	100.0	100.0	N=474	N=2029	9572	N=9552
Main source of drinking water [A]						
Improved sources	100.0	100.0	N=639	N=2502	10890	N=11342
Piped water	100.0	100.0	N=250	N=714	2877	N=2902
Tubewell/Borehole	100.0	100.0	N=264	N=1308	6058	N=6373
Protected well or spring	100.0	100.0	N=111	N=412	1810	N=1926
Bottled water	100.0	100.0	N=14	N=68	145	N=141
Unimproved sources	100.0	100.0	N=178	N=540	2875	N=2516
Unprotected well or spring	100.0	100.0	N=101	N=251	1358	N=1181
Tanker-truck/Bicycle with Jerrycan	100.0	100.0	N=2	N=12	48	N=40
Surface water	100.0	100.0	N=55	N=214	1140	N=1016
Rainwater	100.0	100.0	N=18	N=55	302	N=249
Sachet water	100.0	100.0	N=2	N=6	23	N=25
Other	-	0.0	N=.	N=2	4	N=5

[1] MICS indicator WS.4 - Faecal contamination of source water
[H] Arsenic as As (mg/L): Urban: Arsenic <= 0.010, Low risk, Acceptable; Arsenic >= 0.011, High risk, Not Acceptable; and Rural: Arsenic <= 0.010, Low risk, Acceptable; Arsenic >= 0.011, High risk, Not Acceptable.
(*) Figures denoted by an asterisk are based on denominators of less than 25 unweighted cases
( ) Figures are based on denominators 25-49 unweighted cases
N=Unweighted cases

Table 4.2: Quality of source drinking water Fluorides (mg/L))
Percent distribution and percentage of household population at risk of exposure Fluorides (mg/L) detected in source drinking water, UDHS2022

Characteristic	Chemical: Fluorides (mg/L)[F]						
	Low risk, Acceptable	High risk, Not Acceptable	Total				
Total	**97.7**	**2.3**	**100.0**	**N=2386**	**N=3042**	**13765**	**N=13858**
Type of place of residence							
Urban	98.2	1.8	100.0	N=879	N=1013	4193	N=4306
Rural	97.4	2.6	100.0	N=1507	N=2029	9572	N=9552
Main source of drinking water [A]							
Improved sources	97.1	2.9	100.0	N=1943	N=2502	10890	N=11342
Piped water	96.0	4.0	100.0	N=650	N=714	2877	N=2902
Tube well/Borehole	97.4	2.6	100.0	N=941	N=1308	6058	N=6373
Protected well or spring	98.3	1.7	100.0	N=302	N=412	1810	N=1926
Bottled water	100.0	0.0	100.0	N=50	N=68	145	N=141
Unimproved sources	99.6	0.4	100.0	N=443	N=540	2875	N=2516
Unprotected well or spring	99.3	0.7	100.0	N=228	N=251	1358	N=1181
Tanker-truck/Bicycle with Jerry can	(*)	(*)	100.0	N=11	N=12	48	N=40
Surface water	100.0	0.0	100.0	N=160	N=214	1140	N=1016
Rainwater	(99.6)	(.4)	100.0	N=37	N=55	302	N=249
Sachet water	(*)	(*)	100.0	N=5	N=6	23	N=25
Other	(*)	(*)	100.0	N=2	N=2	4	N=5

[1] MICS indicator WS.4 - Faecal contamination of source water
[F] Fluorides (mg/L): Urban: Fluoride <= 1.50, Low risk, Acceptable; Fluoride >= 1.51, High risk, Not Acceptable; and Rural: Fluoride <= 1.50, Low risk, Acceptable; Fluoride >= 1.51, High risk, Not Acceptable.
(*) Figures denoted by an asterisk are based on denominators of less than 25 unweighted cases
( ) Figures are based on denominators 25-49 unweighted cases
N=Unweighted cases

Table 4.3: Quality of source drinking water Nitrates as NO3-(mg/L))
Percent distribution and percentage of household population at risk of exposure Nitrates as NO3-(mg/L) detected in source drinking water, UDHS 2022

Characteristic	Chemical: Nitrates as NO3-(mg/L)[G]						
	Low risk, Acceptable	High risk, Not Acceptable	Total				
Total	**99.5**	**0.5**	**100.0**	**N=2230**	**N=3042**	**13765**	**N=13858**
Type of place of residence							
Urban	99.9	0.1	100.0	N=869	N=1013	4193	N=4306
Rural	99.4	0.6	100.0	N=1361	N=2029	9572	N=9552
Main source of drinking water [A]							
Improved sources	99.4	0.6	100.0	N=1824	N=2502	10890	N=11342
Piped water	100.0	0.0	100.0	N=646	N=714	2877	N=2902
Tubewell/Borehole	99.1	0.9	100.0	N=844	N=1308	6058	N=6373
Protected well or spring	99.2	0.8	100.0	N=283	N=412	1810	N=1926
Bottled water	100.0	0.0	100.0	N=51	N=68	145	N=141
Unimproved sources	100.0	0.0	100.0	N=406	N=540	2875	N=2516
Unprotected well or spring	100.0	0.0	100.0	N=197	N=251	1358	N=1181
Tanker-truck/Bicycle with Jerrycan	(*)	(*)	100.0	N=11	N=12	48	N=40
Surface water	100.0	0.0	100.0	N=155	N=214	1140	N=1016
Rainwater	(100.0)	(.0)	100.0	N=37	N=55	302	N=249
Sachet water	(*)	(*)	100.0	N=5	N=6	23	N=25
Other	(*)	(*)	100.0	N=1	N=2	4	N=5

[1] MICS indicator WS.4 - Faecal contamination of source water
[G] Nitrates as NO3-(mg/L): Urban: Nitrates <= 45.0, Low risk, Acceptable; Nitrates >= 45.1, High risk, Not Acceptable; and Rural: Nitrates <= 45.0, Low risk, Acceptable; and Nitrates >= 45.1, High risk, Not Acceptable.
(*) Figures denoted by an asterisk are based on denominators of less than 25 unweighted cases
( ) Figures are based on denominators 25-49 unweighted cases
N=Unweighted cases

Table 4.4: Quality of source drinking water Lead as Pb (mg/L))
Percent distribution and percentage of household population at risk of exposure Lead as Pb (mg/L) detected in source drinking water, UDHS 2022

Characteristic	Chemical: Lead as Pb (mg/L)[I]						
	Low risk, Acceptable	High risk, Not Acceptable	Total				
Total	**72.3**	**27.7**	**100.0**	**N=794**	**N=3042**	**13765**	**N=13858**
Type of place of residence							
Urban	78.2	21.8	100.0	N=338	N=1013	4193	N=4306
Rural	68.3	31.7	100.0	N=456	N=2029	9572	N=9552
Main source of drinking water [A]							
Improved sources	73.2	26.8	100.0	N=620	N=2502	10890	N=11342
Piped water	73.5	26.5	100.0	N=244	N=714	2877	N=2902
Tubewell/Borehole	71.1	28.9	100.0	N=259	N=1308	6058	N=6373
Protected well or spring	77.4	22.6	100.0	N=104	N=412	1810	N=1926
Bottled water	(*)	(*)	100.0	N=13	N=68	145	N=141
Unimproved sources	69.9	30.1	100.0	N=174	N=540	2875	N=2516
Unprotected well or spring	72.5	27.5	100.0	N=101	N=251	1358	N=1181
Tanker-truck/Bicycle with jerrycan	(*)	(*)	100.0	N=2	N=12	48	N=40
Surface water	62.5	37.5	100.0	N=53	N=214	1140	N=1016
Rainwater	(*)	(*)	100.0	N=18	N=55	302	N=249
Sachet water	-	-	0.0	N=.	N=6	23	N=25
Other	-	-	0.0	N=.	N=2	4	N=5

[1] MICS indicator WS.4 - Faecal contamination of source water
[I] Lead as Pb (mg/L): Urban: Lead <= 0.010, Low risk, Acceptable; Lead >= 0.011, High risk, Not Acceptable; and Rural: Lead <= 0.010, Low risk, Acceptable; Lead >= 0.011, High risk, Not Acceptable.
(*) Figures denoted by an asterisk are based on denominators of less than 25 unweighted cases
( ) Figures are based on denominators 25-49 unweighted cases
N=Unweighted cases

Table 4.5 : Quality of source drinking water (Lab Test)

Percent distribution and percentage of household population at risk of exposure Physical quality Fluorides (mg/L), Nitrates as NO3-(mg/L-N), Arsenic as As (mg/L), and Lead as Pb (mg/L) detected in source drinking water, DHS Uganda, 2022

Characteristic	Fluorides (mg/L)[F]			Nitrates as NO3-(mg/L-N)[G]			Arsenic as As (mg/L)[H]			Lead as Pb (mg/L)[I]		
	Low risk, Acceptable	High risk, Not Acceptable	Missing	Low risk, Acceptable	High risk, Not Acceptable	Missing	Low risk, Acceptable	High risk, Not Acceptable	Missing	Low risk, Acceptable	High risk, Not Acceptable	Missing
Type of place of residence												
Urban	86.1	1.6	12.3	86.4	0.1	13.5	31.9	3.6	64.5	18.5	16.8	64.7
Rural	71.1	1.9	27.1	66.3	0.4	33.2	20.2	2.9	76.9	6.4	15.8	77.9
Main source of drinking water												
Improved sources	74.0	2.2	23.8	71.1	0.4	28.5	23.1	2.4	74.5	10.1	14.6	75.3
Piped water	87.6	3.7	8.8	90.6	0.0	9.4	29.8	4.6	65.6	16.9	16.1	67.0
Tubewell/Borehole	67.9	1.8	30.3	62.7	0.6	36.7	18.9	1.3	79.8	7.3	12.8	79.9
Protected well or spring	73.2	1.3	25.5	68.5	0.6	30.9	26.9	2.5	70.6	9.1	18.5	72.5
Bottled water	68.2	0.0	31.8	69.1	0.0	30.9	15.6	5.4	79.0	5.2	11.9	82.9
Unimproved sources	81.9	0.3	17.8	77.5	0.0	22.5	26.4	5.5	68.0	9.8	21.8	68.5
Unprotected well or spring	89.9	0.6	9.5	81.9	0.0	18.1	27.9	7.0	65.1	10.4	24.5	65.1
Surface water	77.3	0.0	22.7	75.9	0.0	24.1	23.7	3.8	72.5	8.8	18.1	73.1
Rainwater	63.9	0.3	35.8	64.2	0.0	35.8	29.9	6.7	63.4	13.1	23.5	63.4

CHAPTER 5: SAFELY MANAGED WATER

Sustainable Development Goals (SDGs) set ambitious targets for the measurement and reporting of drinking water, sanitation and hygiene (WASH). For SDG reporting, the JMP categorizes improved water and sanitation facilities into Safely Managed: Basic and Limited services. Estimates of population using safely managed drinking water, sanitation services and basic hygiene services are used by JMP for reporting of SDG targets 6.1 and 6.2. This chapter presents safely managed water, sanitation and hygiene based on a nationally representative sample for microbiological water quality testing.

5.1 Drinking water services

Safely Managed drinking water services refer to the accessibility, availability and quality of the main source used by households for drinking, cooking, personal hygiene and other domestic uses (JMP). In this regard, households using improved drinking water sources located on premises, with water available when needed, free from E. coli contamination and priority chemicals are classified as “safely managed services”. However, households not meeting all the criteria for safely managed, but using an improved source with water collection times of not more than 30 minutes per round trip are classified as ‘basic services. For the case of households using improved sources with water collection times exceeding 30 minutes, those are classified as ‘limited services.

5.1.1 Safely Managed drinking water services

The survey results indicate 15% of the drinking water services are safely managed. By place of residence, 31% of the water sources in Urban and 8% in the rural were safely managed *(Table 5.1 and Table 5.3).* The survey findings are closely compared with the Joint Monitoring Programme safely managed drinking water services estimates of 17% (Table 5.2 and Table 5.4). By place of residence 40% of the safely managed services were in Urban areas and 9% were in the Rural areas.

5.1.2 Basic drinking water services

The survey findings indicate 61% of drinking water services were basic (improved within 30 minutes' travel time). By places of residence 76% were in Urban and 55% were in Rural areas *(Table 5.1).* In Comparison with the JMP estimates of the same year (2022), 60% of the drinking water services were basic. By place of residence 79% were in Urban and 53 were in the rural areas *(Table 5.2).*

5.1.3 Limited Drinking water services

The results of the survey show that 20% of the drinking water services were basic (greater than 30 minutes walking distance). By place of residence 12% in Urban and 29% in Rural areas. Compared to the JMP estimates, basic services represented 25% of which 14% were located in Urban places of residence and 29% in rural areas.

Table 5.1: Drinking Water Service Levels based on UDHS 2022

Drinking Water service levels	Urban	Rural	Total
Improved water	89	78.3	81.7
Safely managed drinking water	31.3	8.1	15.1
At least basic (improved within 30 mins)	76.2	55.1	61.1
Limited (improved > 30 mins)	12.2	23.5	20.2
Unimproved water	8.5	12.7	11.5
Surface water	3.2	8.7	7.1

Table 5.2: Drinking Water Service Levels based on estimates by JMP

Drinking Water service levels	Urban	Rural	Total
Improved water	92.6	81.3	84.3
Safely managed drinking water	39.9	8.8	16.9
At least basic (improved within 30 mins)	79.1	52.7	59.6
Limited (improved > 30 mins)	13.5	28.6	24.6
Unimproved water	6.1	12.9	11.1
Surface water	1.3	5.8	4.6

Source: JMP Report 2024

Table 5.3 Household drinking water

Percent distribution of households and de jure population by source of drinking water, time to obtain drinking water, and treatment of drinking water, according to residence, UDHS 2022

Characteristic	Households			Population		
	Urban	Rural	Uganda	Urban	Rural	Uganda
Source of drinking water						
Improved source	**89.0**	**78.3**	**81.7**	**88.3**	**78.6**	**81.4**
Piped into dwelling/yard/plot	17.3	2.0	6.9	17.8	2.0	6.5
Piped to neighbor	19.5	3.0	8.3	16.9	2.4	6.6
Public tap/standpipe	11.4	6.1	7.8	10.7	5.9	7.3
Tubewell/borehole	22.1	50.7	41.6	24.9	52.2	44.4
Protected dug well	6.7	6.1	6.3	7.1	6.3	6.5
Protected spring	6.5	8.6	7.9	7.0	8.4	8.0
Rainwater	2.6	1.4	1.8	2.7	1.2	1.6
Bottled water	2.7	0.4	1.2	1.3	0.2	0.5
Sachet water	0.2	0.1	0.1	0.1	0.1	0.1
Unimproved source	**11.0**	**21.7**	**18.3**	**11.7**	**21.5**	**18.7**
Unprotected dug well	4.9	9.5	8.0	5.2	9.3	8.1
Unprotected spring	2.1	3.2	2.9	2.3	3.2	2.9
Tanker truck	0.7	0.2	0.4	0.8	0.2	0.4
Bicycle with jerrycan	0.3	0.1	0.2	0.2	0.1	0.1
Surface water	3.0	8.6	6.8	3.2	8.7	7.1
Time to obtain drinking water (round trip)						
Water on premises[2]	44.1	9.2	20.0	41.5	8.5	17.7
Less than 30 minutes	41.1	60.3	54.3	41.1	59.4	54.3
30 minutes or longer	14.6	30.4	25.5	17.3	32.1	27.9
Don't know	0.2	0.2	0.2	0.1	0.1	0.1
Water treatment prior to drinking[3]						
Boil	63.9	32.4	42.5	62.1	30.7	39.7
Bleach/chlorine added	1.3	1.7	1.6	1.6	2.0	1.9
Strain through cloth	0.9	1.6	1.4	1.1	1.6	1.5
Ceramic, sand or other filter	0.5	0.3	0.4	0.6	0.3	0.4
Solar disinfection	0.1	0.0	0.1	0.1	0.0	0.1
Let it stand and settle	0.5	0.8	0.7	0.5	0.8	0.7
No treatment	33.9	64.3	54.6	64.7	34.3	43.0
Percentage using an appropriate treatment method[4]	65.3	34.1	44.1	63.8	32.7	41.6
Number	**6,323**	**13,435**	**19,758**	**25,792**	**64,349**	**90,142**

[1] Because the quality of bottled water is not known, households using bottled water for drinking are classified as using an improved or unimproved source according to their water source for cooking and handwashing.

[2] Includes water piped to a neighbor

[3] Respondents may report multiple treatment methods so the sum of treatment may exceed 100 percent.

[4] Appropriate water treatment methods include boiling, bleaching, filtering and solar disinfecting.

Table 5.4 Drinking water service ladder

Percent distribution of de jure population by drinking water service ladder, according to background characteristics, UDHS 2022

Background characteristic	At least basic service[1]	Limited service[2]	Unimproved[3]	Surface water	Total	Number of persons
Residence						
Urban	76.2	12.2	8.5	3.2	100	25,792
Rural	55.1	23.5	12.7	8.7	100	64,349
Sub Region						
Kampala	97.7	0.7	1.0	0.6	100	3,374
Buganda	62.7	13.1	16.4	7.7	100	20,579
Busoga	67.8	24.8	2.4	5.0	100	9,157
Bukedi	75.4	23.3	1.2	0.0	100	5,165
Elgon	72.1	9.9	12.4	5.6	100	4,697
Teso	57.0	40.4	1.3	1.2	100	6,442
Karamoja	71.7	19.4	0.9	8.0	100	4,954
Lango	53.8	29.8	14.9	1.5	100	6,063
Acholi	45.3	34.5	18.7	1.5	100	3,723
West Nile	60.5	22.6	8.5	8.4	100	3,389
Bunyoro	55.7	21.8	14.4	8.1	100	5,615
Toro	47.4	11.4	23.0	18.2	100	6,572
Ankole	48.9	19.6	16.8	14.7	100	6,717
Kigezi	44.5	23.4	17.0	15.1	100	3,696
Wealth quintile						
Lowest	53.9	26.5	10.6	9.0	100	18,033
Second	50.3	26.0	13.8	9.9	100	18,030
Middle	53.5	22.8	15.1	8.5	100	18,023
Fourth	62.2	19.7	12.2	5.9	100	18,027
Highest	85.7	6.1	5.7	2.4	100	18,028
Total	61.1	20.2	11.5	7.1	100	90,142

Note: Service ladder concept/definitions are based on the WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation, and Hygiene (JMP).

[1] Defined as drinking water from an improved source, provided either water is on the premises or round-trip collection time is 30 minutes or less. Includes safely managed drinking water, which is not shown separately.

[2] Drinking water from an improved source, and round-trip collection time is more than 30 minutes or is unknown

[3] Drinking water from an unprotected dug well or unprotected spring

Table 5.5: Safely managed drinking water services
Percentage of household population with drinking water free from faecal contamination, available when needed, and accessible on premises, for users of improved and unimproved drinking water sources and percentage of household members with an improved drinking water source located on premises, free of E. coli and available when needed, UDHS 2022

	Improved sources				Unimproved sources				Percentage of household members with an improved drinking water source located on premises, free of E. coli and available when needed [1]	Number of households	Number of household members with information on water quality	Number of HH members
	Without E. coli in drinking water source	With drinking water available in sufficient quantities	Drinking water accessible on premises	Number of household members with information on water quality who are using improved sources	Without E. coli in drinking water source	With drinking water available in sufficient quantities	Drinking water accessible on premises	Number of household members with information on water quality who are using unimproved sources				
Total	**49.6**	**68.3**	**15.8**	**11263**	**8.2**	**61.3**	**2.9**	**2502**	**5.2**	**N=3042**	**13765**	**N=13858**
Type of place of residence												
Urban	47.2	68.3	31.3	3749	9.2	61.4	2.1	444	11.4	N=1013	4193	N=4306
Rural	50.8	68.4	8.1	7514	8	61.3	3.1	2058	2.5	N=2029	9572	N=9552
Main source of drinking water [A]												
Improved sources	50.3	67.9	13.8	10890	-	-	-	-	6.1	N=2502	10890	N=11342
Piped water	53.3	68.7	38.5	2877	-	-	-	-	16.5	N=714	2877	N=2902
Tube well/Borehole	57.9	65.2	4.3	6058	-	-	-	-	2.1	N=1308	6058	N=6373
Protected well or spring	18.3	75.2	4.6	1810	-	-	-	-	1.3	N=412	1810	N=1926
Bottled water	73.4	75.9	37	145	-	-	-	-	25.9	N=68	145	N=141
Unimproved sources	28.5	80.8	74.5	373	8.2	61.3	2.9	2502	2	N=540	2875	N=2516
Unprotected well or spring	-	-	-	-	8.8	56.8	2.9	1358	0	N=251	1358	N=1181
Surface water	-	-	-	-	7.4	66.8	2.6	1140	0	N=214	1140	N=1016
Rainwater	28	83.9	81.8	302	-	-	-	-	18.6	N=55	302	N=249
Wealth index quintile												
Lowest	54.1	62.3	2	2230	9.9	59.9	0.8	518	0.8	N=710	2747	N=3036
Second	42.7	66.6	4.5	1867	5.2	58.3	3.4	604	1.1	N=560	2470	N=2663
Middle	48	69.9	7.1	2128	2.4	69.7	2.1	580	2.4	N=515	2708	N=2628
Fourth	44.8	63.1	15.7	2187	17.4	57.4	4	620	4.2	N=570	2807	N=2670
Highest	55.4	77	40.6	2852	0.2	61.7	6.3	180	16	N=687	3032	N=2861

Table 5.5: Safely managed drinking water services
Percentage of household population with drinking water free from faecal contamination, available when needed, and accessible on premises, for users of improved and unimproved drinking water sources and percentage of household members with an improved drinking water source located on premises, free of E. coli and available when needed, UDHS 2022

Characteristic	Improved sources				Unimproved sources				Percentage of household members with an improved drinking water source located on premises, free of E. coli and available when needed [1]	Number of households	Number of household members with information on water quality	Number of HH members
	Without E. coli in drinking water source	With drinking water available in sufficient quantities	Drinking water accessible on premises	Number of household members with information on water quality who are using improved sources	Without E. coli in drinking water source	With drinking water available in sufficient quantities	Drinking water accessible on premises	Number of household members with information on water quality who are using unimproved sources				
Sub Region												
Kampala	77.1	72.9	35.7	518	0	71.7	71.7	5	23.5	N=201	523	N=722
Buganda	48.6	72.4	28.7	2386	9.7	53.6	1.7	845	8.8	N=458	3231	N=1947
Busoga	67	54.9	5.8	1315	2.3	16.7	0	76	1.7	N=278	1391	N=1444
Bukedi	86.8	85.2	11.8	784	32.5	32.5	0	11	10	N=176	794	N=921
Elgon	17.2	74	5	573	11.4	88.3	2.7	97	1.8	N=182	670	N=824
Teso	37.8	51.4	4.9	959	0	0	0	15	1.3	N=190	975	N=1063
Karamoja	76	52.5	2.5	716	28.1	54.1	0	56	0.1	N=167	772	N=694
Lango	45.7	65.3	9.4	780	7.3	49.8	0	161	1.4	N=209	941	N=994
Acholi	49.7	51.3	5.9	397	0	79.1	5.2	145	1	N=181	542	N=762
West Nile	33.4	57.8	11.3	452	5.9	52.7	1.5	85	1.7	N=221	536	N=1059
Bunyoro	35.4	84.1	10.6	639	6.2	83.4	7.9	130	2.9	N=195	769	N=838
Tooro	23.9	70.8	22.8	600	5.5	65	3.2	408	3	N=188	1008	N=905
Ankole	31.5	89.1	27.6	740	9.5	73.5	3.1	295	7.9	N=224	1035	N=945
Kigezi	38.1	77.1	23	403	8.9	66.7	6	174	4	N=172	577	N=740

[1] MICS indicator WS.6 - Use of safely managed drinking water services; SDG indicator 6.1.1

[A] As collected in the Household Questionnaire; may be different than the source drinking water tested

na: not applicable

CHAPTER 6: LIMITATIONS AND RECOMMENDATIONS

Uganda has made significant strides towards access to safe and clean water, improved sanitation, and hygiene Substantial financial investment is still required towards Implementing programmatic and policy recommendations. This chapter presents the key areas of intervention and the corresponding recommendations contributing towards better health outcomes, reduced child mortality, achievement of SDG 6 and Vision 2040.

6.1 Survey limitations with regard to water quality

The survey design and methodology employed in the survey was robust and comprehensive. The following limitations impacted the results in terms of accuracy, representativeness, resulting in generalization of some findings.

The cross-sectional design of the survey provided a snapshot of water quality at a particular point in time but had limitations in terms of assessing changes in water quality over time or identifying seasonal patterns. Nevertheless, the high response rate enhanced the representativeness of the sample, providing a more accurate reflection of the overall water quality conditions across different locations and populations. Furthermore, the design allowed for a robust baseline analysis, capturing a wide range of conditions and variability at the specific point in time, which can serve as a foundation for future studies and monitoring efforts.

The Biomarker Questionnaire gathered valuable information on household water sources, treatment methods, and storage practices, providing insights into the factors that influence water quality. However, the reliance on self-reported data may have introduced biases and inaccuracies, as participants may have over reported the use of improved water sources or treatment methods due to social desirability bias. This potential bias could lead to an overestimation of water safety, which is corroborated by the findings of the E. coli testing, where household water samples showed higher contamination levels compared to source water samples.

This discrepancy suggests that the self-reported data may not accurately reflect the actual water handling and treatment practices, highlighting the need for more objective measures to validate the findings.

6.2 Recommendations

6.2.1 Chemical Water Quality testing

The Chemical water quality response rates particularly for Lead (28%) and Arsenic (28%) limited data analysis for these critical contaminants. For a comprehensive computation and reporting of safely managed water services, future water quality surveys should secure additional funding to improve the testing response rates, expand the parameter scope of chemical analysis and sample size for these contaminants in addition to exploring other cheaper testing options and approaches such as screening for contamination especially the naturally occurring contaminants. Future surveys should adopt longitudinal designs to provide a more comprehensive understanding of water quality and support effective interventions.

6.2.2 Water quality parameters

The survey also focused on four priority chemical contaminants, arsenic, fluoride, nitrate, and lead—due to their widespread health implications. There is a need to expand the scope of the survey to include potentially harmful contaminants, such as pesticides, other heavy metals, or emerging pollutants to provide a comprehensive water quality risk to public health.

6.2.3 Sampling and sample handling

The Sample collection method used in this study may not have accounted for potential contamination introduced by unsanitary handling of taps or tubewell spouts by users. The approach is consistent with the recommendations of the Joint Monitoring Program (JMP), which emphasizes the importance of simulating real-life conditions during water sampling. Its recommended to assess the impact of contamination introduced by the unsanitary handling of taps and tube wells.

Transportation of samples from the field to the laboratory was observed that delayed the analysis start time and reporting of the results. Most of the samples were stored with the field teams for a prolonged time that may affect the integrity of the sample. In the future surveys shorter holding times of samples is recommended to improve the accuracy and reliability of the laboratory test results.

6.2.4 Test Methods and Standard Operating Protocols

The study's methodology was rigorous and aligned with international standards. The narrow scope of chemical analysis, potential sample contamination, and reliance on self-reported data—highlight areas require improvement in future surveys. Addressing these challenges, including expanding the range of water quality parameters, and refining data collection protocols, could strengthen the reliability and applicability of findings. However, despite these limitations, the study offers valuable insights into water quality and associated factors, informing policy and programmatic decisions to improve drinking water safety.

6.2.5 Safely managed water, sanitation and hygiene services

a) Increased investments in upgrading and maintaining water infrastructure, particularly in rural and urban areas to reduce contamination at the source. Community-based hygiene and sanitation education programs should be scaled up to promote safe water handling practices, including the use of clean storage containers, regular cleaning of water storage facilities, and proper handwashing techniques.

b) Increase budgetary allocations for WASH programs and explore innovative financing mechanisms, such as social impact bonds and climate finance, to fund water and sanitation infrastructure.

c) Prioritize provision of affordable and accessible point-of-use water treatment solutions, such as chlorine tablets or ceramic filters, to households, especially those relying on distant water sources.

d) Prioritize and implement a dual approach focusing on improving drinking water source quality and addressing post-source contamination for areas of high E. coli contamination at source and household drinking water.

e) Governments and development partners integrate water quality monitoring systems for both source and households to track contamination trends and evaluate the effectiveness of interventions.

f) Private sector explores and provides affordable household treatment technologies, water treatment products especially in rural areas.

6.2.6 Data and information

a) Governments and relevant stakeholders invest in robust data collection mechanisms on sewage treatment and disposal, testing of water quality at both the source and household levels, as well as tracking progress towards SDG 6 targets.

b) Mainstream household-level surveys into national water and sanitation monitoring programs, leveraging mobile technology for real-time data reporting, and training local authorities to systematically record information on sewage management practices.

c) Government conducts comprehensive investigations to identify the sources of lead contamination and implements mitigation measures including replacing lead-containing pipes and fittings in water supply systems and promoting the use of lead-free materials in new infrastructure.

d) Promote and support collection of disaggregated data on WASH by urban and rural areas to identify disparities and inform targeted interventions

e) Strengthen partnerships with research institutions and NGOs to generate evidence-based solutions for improving water quality and sanitation.

6.2.7 Public awareness, communication and education

Campaigns should also be launched to educate communities about the dangers of lead exposure and the importance of using safe water storage containers.

While access to improved water sources has increased, the proportion of households with safely managed drinking water remains low. The government should invest in expanding piped water systems, particularly in rural areas, to ensure that water is available on premises and free from contamination. Community-based water management systems should be strengthened, and local water committees should be trained to maintain water infrastructure and monitor water quality. Additionally, efforts should be made to reduce the time spent collecting water, especially for women and children, by increasing the number of water points in underserved areas.

6.2.8 Gender and equity issues

Promote Gender-Responsive WASH Programs for women and girls who are primarily responsible for collecting water. WASH programs should be designed to reduce their burden and ensure their safety includes providing water points closer to homes, ensuring safe and accessible sanitation facilities.

Government prioritizes construction of improved sanitation facilities, particularly in rural areas, and promotes the use of shared sanitation facilities in urban informal settlements.

Promote WASH campaigns on handwashing with soap at critical times targeting schools and healthcare facilities as key entry points for hygiene education, and community-led total sanitation (CLTS) approaches to eliminate open defecation.

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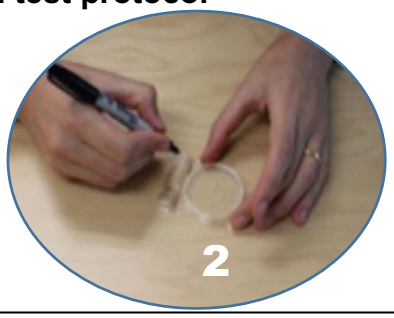
ANNEXES

Annex 1 Microbiological test protocol

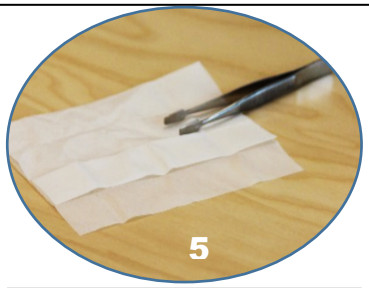
Sanitize or wash hands thoroughly with soap and dry with a paper towel.



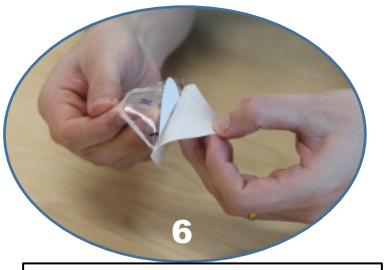
Use the Marker pen.to label the Compact disc. Example label: H-012-03 where: H = household sample, S = source sample, B = blank test, **Numbers**: cluster + household

Tear open an alcohol wipe

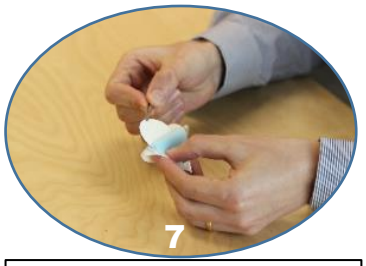
Use the alcohol wipe to sterilize the forceps and the top of the filtration stand and frit (use forceps to keep wipe from sticking to the rough surface)



Place the forceps on top of an alcohol wipe to keep it sterile.



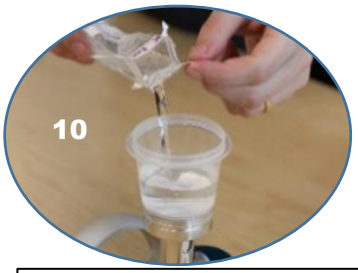
Remove one membrane filter from box



Remove the white gridded filter (discard the blue paper) – *do not allow the filter to* touch any other surfaces; if dropped accidentally, use a new one.

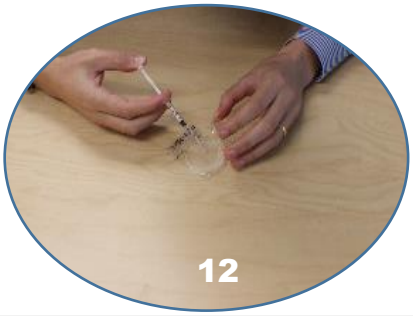
Remove funnel from the plastic sleeve; *be careful not to touch the inside of the funnel*

Lock the funnel onto the filtration stand, touching only the outside of the funnel



Fill the funnel with the water sample up to the 100 mL mark

Open one sterile 1 mL disposable syringe and withdraw 1 mL of sample water



Use the other hand to lift off the cover of the Compact Dry plate and add the 1 mL from the syringe

Switch the blue valve on the filtration stand into the open position (vertical)

Use the large syringe to pull the entire water sample through the filter; discard the water in the syringe

Carefully remove and discard the funnel, leaving the filter on the filtration stand

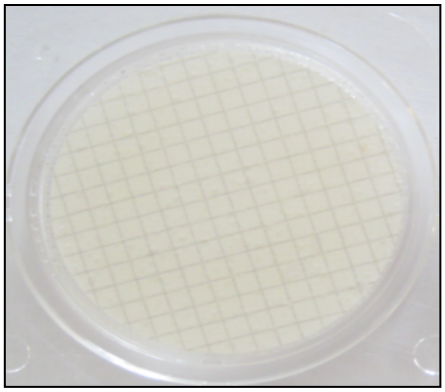
Use the sterile forceps to remove the filter from the filtration stand

Place the filter, gridded side up, onto the plate

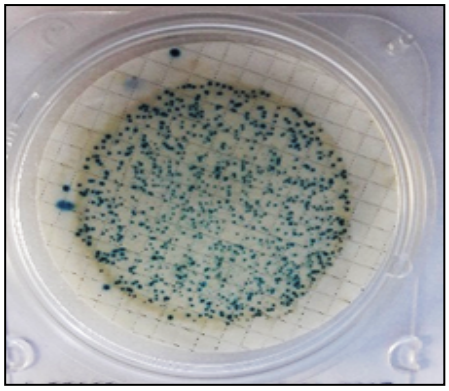
Wipe down the surface of the filtration stand and allow any water still inside to drain out

Place the Compact dry plate into the incubation belt. Incubate for 24-48 hours and then record result in water quality questionnaire.

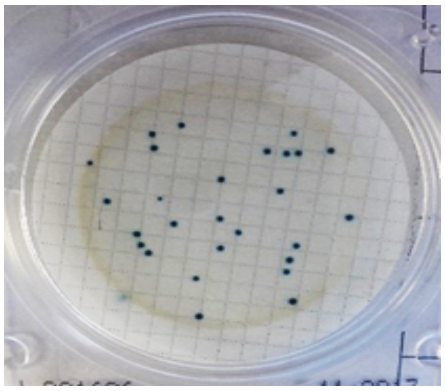
Annex 2 Reading of Microbial Test Results



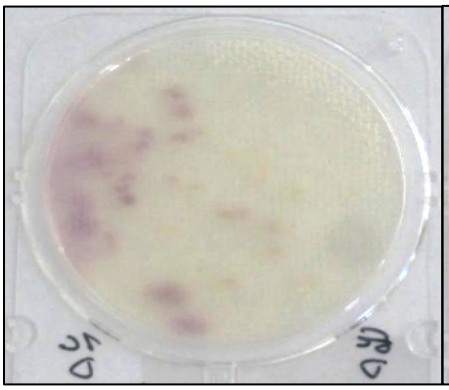
Number of E. coli colonies: 0



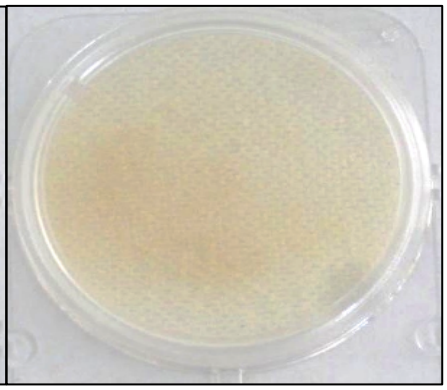
Number of E. coli colonies: 101



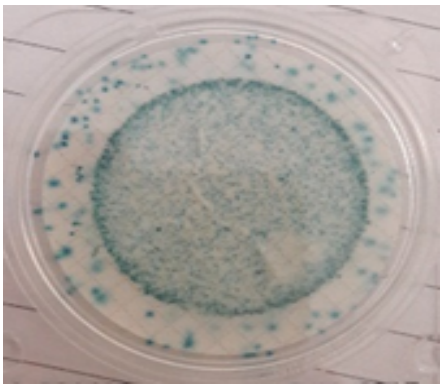
Number of E. coli colonies: 27



Number of E. coli colonies: 0
Diffuse colors do not signify contamination



Number of E. coli colonies: 0
Brown colors does not signify contamination



Number of E. coli colonies: 101
Blue color may indicate many colonies

Annex 3 Arsenic and Lead determination by ICP-OES

Step	Description
1. Preparation of Samples and Standards	Take aliquots of samples to be tested and arrange them in sample trays. Prepare standard solutions for Lead and Arsenic with concentrations of 0.25 mg/L, 0.04 mg/L, and 0.25 mg/L, respectively. Prepare reagent blank solution by adding 5 mL of nitric acid (65%) to 50 mL of deionized water.
2. Instrument Setup and Calibration	Set up the ICP-OES instrument according to the manufacturer's instructions. Allow the instrument to idle for 10 minutes to achieve thermal stability. Select the preferred method from the method file on the WinLab software. Calibrate the instrument using the working standard solutions.
3. Sample Analysis	Run the reagent blank first, followed by the method AQC, and then the samples. Run the AQC after every 10 samples to ensure accuracy and precision
4. Data Retrieval **&** Interpretation	Retrieve the data for the run using the Data Manager software. Export the data to an MS Excel file and arrange it in the required reporting format. Interpret the results, reporting concentrations in mg/L.
5. Quality Control and Assurance	Perform quality control checks, including analysis of AQC samples and replicate samples. Verify the accuracy and precision of the results, ensuring that they are within the established control limits. Maintain records of results, AQC records, and personnel competency as per laboratory requirements

Annex 4 Fluoride and Nitrate determination by Gallery Plus Spectrophotometry

Step	Description
1. Sample Preparation	▯ Filter all samples through a 0.45 µm membrane filter. ▯ Ensure samples are within a pH range of 5 to 9. Adjust if necessary.
2. Calibration	▯ Prepare a series of calibration standard solutions for Fluoride and Nitrate using stock standard solutions and include a zero-concentration solution (blank). ▯ Establish a calibration function for each parameter by analyzing the calibration solutions and confirm the validity of the function ($R^2 \geq 0.999$).
3. Analysis	▯ Analyze samples following the manufacturer's instructions ▯ Analyze a quality control sample (AQC) at the start of the analysis, after every 10 samples, and at the end of the run. Ensure the AQC falls within 2 standard deviation (±2SD) of the expected value.
4. Fluoride Analysis	▯ Reagents used included Fluoride R1, Fluoride R2 and Fluoride R3 ▯ The discrete analyzer will automatically dispense the appropriate reagents and measure the absorbance at 620 nm.
5. Nitrate Analysis	▯ Reagents used included Sodium Hydroxide (TON Reagent 1), Reductant reagent (TON Reagent 2) and Color (NED) Reagent (TON Reagent 3) ▯ **Procedure:** The discrete analyzer will automatically perform the following steps: i. Reduction of nitrate to nitrite using hydrazine sulfate. ii. Reaction of nitrite with sulfanilamide and NED to form a colored compound. iii. Measurement of absorbance at 540 nm
6. Results	▯ The equipment software automatically calculates the mass concentration of Fluoride and Nitrate from the calibration line using absorbance values. ▯ Report results in mg/L, with a maximum of three significant figures. ▯ Express results for Nitrate and Fluoride as mg/L of the respective analyte.

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